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TABLE OF CONTENTS

Inspiration. R. L. Sackett, President 359
The Institutional Division. C. E. Magnusson, Vice-President 360
Board of Investigation:
Summer School for Engineering Teachers. H. P. Hammond.. 361
Description of Procedures of the Personnel System for the Schools of Engineering, Purdue University, J. E. Walters 455
The Annual Meeting:
The Engineer in his Civic and Public Relationships. Paul Cloke 498
The Relation of Economics to the Work of the Engineer. John H. Ashworth 505
Discussion: A Suggested Method of Presenting Newton's Law of Motion 511
T. F. Hickerson 511
Robins Fleming 513
Extension of Engineering Education in the Metropolitan Area. W. E. Wickenden 515
Obituary:
Emile Jerome Fermier 517
Hazen Greeley Tyler 518
College Notes:
Polytechnic Institute of Brooklyn i
University of Detroit i
University of Louisville ii
University of Maine iii

University of Michigan iv
University of New Mexico v
New Members vi
Items of Interest vii
Sections and Branches:
Greater New York and Northern New Jersey Section viii
Book Reviews xi

INSPIRATION

BY R. L. SACKETT,

President of the Society

Much has been written about those who are divinely chosen to be doctors, lawyers and teachers. Certainly the choice should be made only after devout thought and prayerful consideration of physical, mental and spiritual fitness for the calling in question.

We have heard ministers who may have been divinely inspired to enter that high calling. But they leaned too much on inspiration and too little on their own continued perspiration. The teacher needs to be devout in his attitude and to feel that his profession is the greatest in the world, *for him*, but he should also continue unceasingly to improve his technique and his appeal to the human interest of his students.

Lawyers, doctors and ministers come into intimate contact with their clients, patients or parishoners. Their service is individual. If you get a company of old grads together they will talk about their college escapades and about the teachers who knew them and inspired them.

One problem before the engineering colleges is this: How are we to maintain and enlarge that intimate, human touch with our students which may constitute our greatest contribution to their growth. Will not a larger measure of appreciation come to the teacher who values such *human* resources and develops *them*?

We have been too much engrossed in utilizing our material resources. It is time to inject a measure of idealism into engineering education and to realize that the teacher who is not an inspiration is short in his spiritual accounts.

THE INSTITUTIONAL DIVISION

BY C. E. MAGNUSSON,

Vice-President of the Society

At the Annual Convention last June the institutional members were formally designated as the Institutional Division of the Society, with specified function and a nucleus of organization. The function of the new Division is to deal with problems of primary interest to educational institutions, as such; that is, such matters as the recognition of degrees and other credentials, admission requirements and procedure, personnel systems, cost and fees, teacher training in summer schools and otherwise, coordination of scholastic and post-scholastic education and similar problems. In the organization it is provided that representation in the Institutional Division be through one or more delegates, appointed severally by the institutional members, and the form of voting is specified. The only additional province specified in the enabling act is that the Chairman of the Institutional Division shall be appointed by the President of the Society.

The records of the Society show that at present there are one hundred and twenty institutional members in good standing. As each institutional member is entitled to one or more delegates it becomes evident that the Institutional Division will not lack in power for want of members, but may prove unwieldy and necessarily will require much more time for action than a small compact committee. In the past it appears to have been the custom for institutional members to appoint delegates to the S. P. E. E. late in the spring for the sole purpose of having representation at the Annual Convention. The enlarged field of action, with concurrent increase in duties and obligations assigned to the institutional members by the creation of the Institutional Division of the Society, makes it imperative that the official delegate be appointed for

active service throughout the year, and not merely to represent the institution at the annual convention.

That there is much work that should be done by the Institutional Division no one will question. As successor to the Division of Deans and Administrative Officers, the Institutional Division falls heir, not only to the invaluable results of years of arduous labor, but also to a wealth of unsolved problems pressing for solution. Moreover, the rapidly changing conditions in the industries and the world at large create new problems or require readjustments of established conditions in educational institutions. Thus the transformation of four-year high schools into junior colleges gives a new angle to the problem of admission to advanced standing, which is of special interest to engineering colleges and technical schools.

However, the first problem before the institutional delegates is to decide on a line of policy which will guide the administrative officers, from year to year, in the preparation of programs for the meetings of the Institutional Division.

THE SUMMER SCHOOL FOR ENGINEERING TEACHERS *

FOREWORD

This Bulletin presents a record of the inception of the Summer School for Engineering Teachers and an account of the proceedings of its first sessions. The School was inaugurated as one of the constructive measures growing out of the general investigation of engineering education conducted during the years 1924 to 1926 inclusive by the Society for the Promotion of Engineering Education. Both the general investigation and the Summer School were supported by grants of funds from the Carnegie Corporation of New York.

The Bulletin explains the general nature of the undertaking, its purposes and scope, the nature of its program and method of conducting it; lists the personnel in attendance; and gives the budget of expenditures. It is intended, in so far as that purpose can be met by a single document, to meet the needs both of those who are already more or less acquainted with the enterprise and of those who learn of it for the first time. The actual proceedings of the two sessions of the School are given in very condensed form. Most of the days' sessions are reported only in outline, though one or two are reproduced in substantially complete detail to serve as examples. In selecting the material to be published, preference has been given to that relating most specifically to methods of teaching. Subject matter to be found in text or reference books is either greatly condensed or omitted entirely. The Bulletin has been prepared by the Staff of the investigation as listed elsewhere, and is based upon complete detailed accounts of the proceedings prepared by the respective secretaries of the two sessions. These complete reports are on file in the office of the Director and may be consulted if desired.

* This is the first of two installments giving an outline of the proceedings of the 1927 sessions of the Society's Summer School for Engineering Teachers. The two installments will constitute Bulletin 14 of the Investigation of Engineering Education. Copyright, 1928, by the Society for the Promotion of Engineering Education. Contents may be quoted with reference to the source.

GENERAL SUMMARY

The purpose of the School is the development of improved methods of teaching the basic subjects of the engineering curriculum. The sessions of 1927 were intended to inaugurate a permanent enterprise to be conducted through sessions held annually in different part of the country and devoted, in turn, to study and discussion of methods of teaching the more important divisions of engineering study. Engineering mechanics was the subject chosen for the sessions of 1927. Two such sessions, each of three weeks duration, were held practically simultaneously, one at Cornell University and one at the University of Wisconsin. Forty-one teachers attended each of the sessions, selections being made from over one hundred applicants. Most of those in attendance were teachers of mechanics, though some were teachers of related subjects. They ranged in maturity from instructors to professors, and represented all types of institutions and all sections of the country. The staff of each school comprised a director, a secretary, three teachers of mechanics, and a group of specialists in various fields. A professional teacher of education also served continuously on each staff and acted as a general adviser and lecturer. The programs of the two sessions included formal lectures, model teaching exercises, demonstration lectures, laboratory exercises, seminars and general group conferences, and committee meetings. Methods of teaching were stressed in all parts of the program, and actual content of subject matter was considered only incidentally. Advanced phases of mechanics and other subjects in which mechanics is largely applied were also considered with the purpose of stimulating interest in those fields and to promote further study and individual effort among those attending. Meetings were held during certain evenings which were addressed by prominent educators and engineers on topics not directly related to the field of engineering education. These were largely of a general or inspirational nature.

The sessions of 1927 were conducted under the general direction of the Board of Investigation and Coordination and the immediate supervision of the Staff of the investigation with the counsel of an advisory committee of the Society. The local directors and faculties cooperated in preparing the programs and conducted the actual work of the sessions.

PART I. PURPOSE, INCEPTION, AND PLAN

Purpose.—The improvement of methods of instruction has been a dominating motive in the Society for the Promotion of Engineering Education since its inception. The Summer School instituted by the Society in 1927 is intended to serve as a direct and practical means to that end by providing centers for the study and discussion of problems of teaching. The underlying plan of the School aims at a concrete approach to these problems through the selection of particular subjects of instruction as the basis of discussion. By selecting one or more subjects of the curriculum for consideration each year, it will be possible in time to cover all of the more important subjects and divisions of engineering study. Review or drill in subject matter enters into the plan only to a subordinate degree. In order to furnish incentive for further study, a portion of the program at each session is devoted to advanced phases of the subject under consideration and to other subjects closely related to it. The intention is not to explore any of these fields in detail, but rather to present their general features and to indicate lines of further effort. An important feature of the plan is the consideration of means better to coordinate instruction in the subject under consideration with other divisions of engineering curricula. The plan also provides for consideration of general educational principles and for the active cooperation of teachers of educational method, both as advisers and as directors of parts of the work.

Schools of this character, to be held in successive years in different parts of the country, are intended to reach a substantial fraction of all engineering teachers directly, and to extend an indirect influence to others. The plan provides for the selection of the teachers attending the schools from all parts of the country and from a considerable variety of institutions. By housing these teachers and the members of

the instructing staff together, encouragement is given to exchange of ideas, leading to broader conceptions of the general problems of engineering education and to new points of view concerning local problems. Observation of the sessions of 1927 confirmed the expectation that the informal features would have a value comparable with that of the more formal parts of the program.

Inception and Precedents.—The School was established to meet needs indicated by a special study of engineering teaching personnel in American colleges, a survey made in the years 1925 and 1926 under the sponsorship of a special committee of the Society and the direct supervision of the Staff of the general investigation. As a result of that study and at the suggestion of the Staff, the committee recommended that the School be conducted as an experimental enterprise for one year under the direction of the Board of Investigation and Coordination, and that if the project proved to be of value, it be continued on a permanent basis. The Board accepted the recommendation and authorized the establishment of the School as a part of the general investigation.

When the inauguration of the School was under consideration, there were no precedents for such an enterprise in the United States, as far as could be learned, either in engineering education or in any other field of professional study. Summer schools for teachers conducted under university auspices had different purposes and employed different methods. It was learned, however, that similar schools were conducted by the Boards of Education of England and Scotland. Director Wickenden visited and observed the English summer school during its session of 1925. While it was found that the methods employed abroad could probably not be adopted in the United States without considerable modification, the English school did furnish a precedent for the essential feature of the undertaking: that of a school conducted under a central organization representing the interests of a large group of institutions rather than under the auspices of a particular university. The only other effort to conduct a summer school

for teachers of engineering, having the study of teaching method as its purpose, had been announced by a prominent university a few years previously, but had not been carried out due to lack of enrollment. It was believed that a society representing all of the institutions might succeed in such an undertaking, however, and the precedent of the success of the English plan gave support to that belief.

Subject of Discussion.—Mechanics was chosen for the sessions of 1927. It was announced, however, that the method pursued would be such that any teacher who had a working knowledge of the principles of mechanics, irrespective of his department of instruction, would benefit by attendance, and that methods of teaching rather than review of subject matter would constitute the major portion of the program. The subject of mechanics seemed to satisfy a number of important requirements in carrying out that aim: It is fundamental in all major engineering curricula and occupies a central position between the basic mathematics and the physical sciences of the first two years and the technological subjects of the later years; its principles are applied widely in the "professional" subjects of the curriculum; its study is an excellent mental discipline and can readily be made the medium for training in habits of thought and methods of work; and finally, not only is it taught by a considerable body of teachers but its principles are understood by a large portion of those who teach the engineering subjects which follow it. Experience demonstrated the wisdom of the selection of mechanics as the topic for the first sessions.

Programs and Methods.—In arranging the program provision was made for a number of different types of exercises, including lectures, "model" classroom exercises, laboratory demonstrations, group discussions, seminars, and committee meetings. Copies of the schedules of the two sessions, which are given in full later, indicate how these several methods were combined into a program. A considerable variety of topics was also included. The formal lectures were devoted to methods of teaching certain parts of the subject. Such ques-

tions as minimum essentials, coordination with other subjects, oral and written quizzing, and other similar topics were considered; also advanced phases of mechanics and other divisions of engineering study, such as electrical engineering, structural engineering, hydraulics, machine design, and the like. The group discussions and seminar meetings were devoted either to the further and more informal consideration of matters previously presented in the formal lectures or to assigned projects requiring the submission of written reports. Certain of the meetings were devoted to the study of laboratory work as an adjunct to courses in mechanics. Demonstrations of typical tests were given and methods of conducting laboratory courses were explained and later discussed. Certain of the periods devoted to formal lectures were set aside for the discussion of matters of general educational importance and were conducted by the educational advisers. At both the Cornell and Wisconsin sessions evening meetings were held two or three days each week, which were addressed by prominent educators and engineers. These were intended to be of a general or inspirational nature.

Complete statements of the programs of the two sessions will be found at the beginning of Parts II and III.

Location and Duration.—In selecting sites for the schools, it was concluded that universities having the proper facilities should be invited to act as hosts, with the understanding that the enterprise should be conducted entirely under the supervision of the Society. The desire was to select institutions located in pleasant environments, having facilities for housing all of the members of the group together, having strong departments of engineering and, especially, a tradition for sound work in engineering mechanics. Cornell University and the University of Wisconsin seemed to fit these specifications admirably, and invitations were accordingly extended to their governing bodies to act as hosts. These invitations were promptly and cordially accepted.

Three weeks was fixed upon as the duration of the first schools, which were held practically simultaneously.

At Cornell the headquarters of the School were in the West Sibley Building of the School of Mechanical Engineering, where all of the morning exercises were held, while the afternoon meetings were held in Lincoln Hall of the School of Civil Engineering. A room was set aside as central headquarters and each of the regular members of the staff was provided with an office or consultation room. At Wisconsin the headquarters of the school were in the Engineering Building, where most of the meetings were held. The general lectures were delivered in the assembly room of the Engineering Building, and the group meetings in smaller seminar rooms. A headquarters room and offices for the members of the staff were also provided. At Cornell the members of the group were housed in Boldt Hall, and at Wisconsin in Tripp Hall. Both of these buildings are recently completed men's dormitories, occupying especially fine locations. The housing facilities at both of the sessions were unusually good and the plan of having the teachers live together was carried out under very favorable circumstances.

Staff.—The teaching staff at each of the two sessions consisted of a local director, a secretary, three teachers of mechanics, and a group of specialists in other fields. Twenty-three members in all served on the two staffs. The local directors headed the teaching staffs of the respective sessions and were in charge of the organization and conduct of the work. The secretaries were charged with the duty of compiling records of proceedings and assisted the directors in handling many of the details of housing, recreation, and the carrying out of the program. At each session the three members of the staff who regularly teach mechanics were in residence for the duration of the work. These men, together with the director and secretary, formed a faculty committee which met regularly to decide matters of policy and of detail in carrying out the programs. The group of specialists associated with each of the sessions lectured or conducted demonstrations either in laboratory work or in subjects closely related to mechanics.

Lists of the staff members will be found at the beginning of Parts II and III.

Teachers Attending.—The effort was to admit a representative group of teachers of a rather wide range of age and experience so that both the older and younger men would profit by exchange of ideas. When the school was first announced a limit of thirty was set upon the attendance at each of the two sessions, but the number of applications was such as to make it advisable to increase the enrollment, and the limit was later raised to forty. This was felt to be the maximum number that could be taken care of on the intimate basis desired. Even with the increased limit a number of applications had to be denied.

A total of eighty-two teachers was finally enrolled; forty-one at each session. In addition a few others attended irregularly as auditors. Sixty-four institutions located in all parts of the country were represented. At the two sessions there were fifteen professors, ten associate professors, twenty-eight assistant professors, twenty-seven instructors, and two of other ranks. Several were teachers of extended experience. On the other hand, some were instructors just beginning their teaching careers. In the announcements of the School, colleges were invited to send representatives and it was advised that wherever possible, the expenses of those attending be paid in full or in part by their institutions. The expenses of about half of the teachers were paid in this way. The others attended entirely at their own expense. Lists of those attending will be found in the September, 1927, issue of the *Journal of Engineering Education.*

Fees.—A registration fee of ten dollars was the only charge for attendance. Each member made his own arrangements and payment for room and board, and all business matters connected with the housing were handled by the local universities.

Participation in the Sessions by Members of the Conference.—It was the desire to have the teachers attending participate in the conduct of the work as actively as possible.

The committee organization through which this was accomplished in part will be discussed in a subsequent paragraph. In addition to the committee work, however, the members of the group were called upon to lead discussions and to present their views concerning methods of teaching and content of courses. Some of the sessions were set aside definitely for this purpose and in many of the others a large part of the work, while led by members of the staff, was actually carried out by members of the group. The "project assignments" also insured participation of all members in the actual work of the sessions.

Committee Organization.—At each of the sessions an advisory committee of members was selected to cooperate with the committee of the staff. These joint committees met regularly to consider matters relating to the program and to act upon the suggestions and wishes of the members of the conference.

Committees of members were also organized to arrange for recreation and to cooperate with the secretaries in recording the proceedings.

A special feature of the Wisconsin session was the organization of a group of committees to consider teaching methods and other educational matters. Each member of the group was appointed to one of these committees. The following subjects were considered:

Objectives in teaching mechanics.
Correlation of analytic mechanics with other subjects.
Minimum essentials in analytic mechanics.
Classroom methods.
Written tests.
Home problem work.
Sample problems.
Apparatus for teaching analytic mechanics.
Organization and administration.

The committees submitted reports which were considered by the entire conference and, after some modifications, adopted as representing the consensus of opinion.

Recreation.—Each of the local faculties tendered a smoker to the visiting teachers at the beginning of the session. Other recreational features included beach picnics, visits to nearby points of interest, tennis tournaments, and the like. At the Cornell session, two afternoons each week were set aside for this purpose, and at Wisconsin also, certain days were devoted to recreation. The members were also extended the privilege of attending the concerts and lectures of the regular university summer schools. At the conclusion of the Cornell session, a subscription dinner was organized, with Irving P. Church, emeritus professor of mechanics, as the guest of honor.

Financial.—The financial support of the School was a special fund of $7,500 appropriated by the Carnegie Corporation of New York. In addition, the registration fees yielded an income of $820, making a total fund of $8,320. The following table gives an itemized statement of disbursements. Since the project was conducted for the first year as a part of the Society's general investigation, no overhead expense of the Headquarters Office was allocated to the School. Traveling expenses of members of the Headquarters Staff were, however, charged to the school fund.

Honoraria of teaching staff	$5,050.00
Travel and subsistence, teaching staff	1,177.71
Clerical and other services	105.50
Travel and subsistence, headquarters staff	460.34
Miscellaneous: Printing, postage, expressage, etc.	298.61
Publication of proceedings	1,200.00
Total	$8,292.16

PART II. PROCEEDINGS OF THE CORNELL SESSION

Teaching Staff, Cornell Session

Director: D. S. Kimball, Dean of the College of Engineering, Cornell University.

Secretary of the Conference: C. L. Walker, Professor of Sanitary Engineering, Cornell University.

Teachers of Mechanics

J. E. Boyd, Professor of Mechanics, Ohio State University.

W. S. Franklin, Professor of Physics, Massachusetts Institute of Technology.

E. W. Rettger, Professor of Mechanics, Cornell University.

Teacher of Laboratory Courses

G. B. Upton, Professor of Experimental Engineering, Cornell University.

Special Lecturers

C. M. Allen, Professor of Hydraulic Engineering, Worcester Polytechnic Institute.

Vladimir Karapetoff, Professor of Electrical Engineering, Cornell University.

M. S. Ketchum, Dean of the College of Engineering, University of Illinois.

Stephan Timoshenko, Westinghouse Electric and Manufacturing Company.

Educational Adviser

R. M. Stewart, Professor of Rural Education, Cornell University.

Program of the Cornell Session

Wednesday, July 6

10:00 A.M. Address of Welcome. Dexter S. Kimball.
The Purposes and Aims of the Summer School for Engineering Teachers. H. P. Hammond.

11:00 A.M. Organization of the Group—Appointment of Committees, etc.

2:00 P.M. The Place of the Study of Mechanics in the Engineering Curriculum. D. S. Kimball.

3:00 P.M. Outline of the Plan and Program of the Summer School. J. E. Boyd.
Discussion.

Thursday, July 7

9:00 A.M. to 11:30 A.M. (with intermission.) The Teaching of the Fundamentals of Mechanics. W. S. Franklin.

2:00 P.M. Group Seminars for discussion of the topic of the morning session. W. S. Franklin, J. E. Boyd, E. W. Rettger.

Friday, July 8

9:00 A.M. The History of Mechanics before Newton. E. W. Rettger.

10:30 A.M. The Teaching of the Fundamentals of Mechanics. W. S. Franklin.

2:00 P.M. Project Assignment: Preparation of Directions for Laboratory Exercises in Mechanics. W. S. Franklin, J. E. Boyd, E. W. Rettger.

Saturday, July 9

9:00 A.M. to Noon. Electromechanics. Vladimir Karapetoff.

P.M. Recreation.

Monday, July 11

9:00 A.M. Equilibrium of Concurrent Co-Planar Forces. J. E. Boyd.

10:30 A.M. The History of Mechanics; Newton and His Successors. E. W. Rettger.

2:00 P.M. Project Assignment: Devising Problems in Statics. W. S. Franklin, J. E. Boyd, E. W. Rettger.

Tuesday, July 12

9:00 A.M. Equilibrium of Non-Concurrent Co-Planar Forces. J. E. Boyd.

10:30 A.M. One Method of Conducting Class Work. E. W. Rettger.

2:00 P.M. Methods of Conducting Undergraduate Classes in Mechanics. S. G. George, W. R. Cornell and K. D. Wood, of the Cornell faculty.

3:00 P.M. Demonstration of Teaching Methods by Members of the Conference.

Wednesday, July 13

9:30 A.M. to Noon. Methods of Conducting Classes in Materials Testing. G. B. Upton.

P.M. Recreation.

Thursday, July 14

9:00 A.M. Center of Gravity and Moment of Inertia. J. E. Boyd.
10:30 A.M. Work and Energy. E. W. Rettger.
2:00 P.M. Project Assignment: Preparation of a Set of Directions for a Laboratory Exercise. J. E. Boyd, W. S. Franklin, E. W. Rettger.

Friday, July 15

9:00 A.M. Couples. E. W. Rettger.
10:30 A.M. Some Teaching Problems Affecting Teachers of Engineers. R. M. Stewart.
2:00 P.M. Model Presentations and Group Discussions of Methods of Conducting Classes in Mechanics.

Saturday, July 16

9:00 A.M. to Noon. Theory of Elasticity. S. Timoshenko. Discussion.
P.M. Recreation.

Monday, July 18

9:00 A.M. Dynamics of Rotation. W. S. Franklin.
10:30 A.M. Experimental Verification of Column Formulas. J. E. Boyd.
2:00 P.M. Group Seminars. J. E. Boyd, W. S. Franklin, E. W. Rettger.

Tuesday, July 19

9:00 A.M. Simple Beams. E. W. Rettger.
10:30 A.M. Statics of Connected Bodies. J. E. Boyd.
2:00 P.M. Project Assignment: Preparation of Examinations. E. W. Rettger, J. E. Boyd, W. S. Franklin.

Wednesday, July 20

9:00 A.M. to Noon. Hydromechanics. C. M. Allen. Discussion.
P.M. Recreation.

Thursday, July 21

9:00 A.M. Continuous Beams. E. W. Rettger.
10:30 A.M. Examples of Mechanical Wave Motion. W. S. Franklin.
2:00 P.M. Symposium on Teaching Methods.

Friday, July 22

9:00 A.M. Examples of Mechanical Wave Motion. W. S. Franklin.
10:00 A.M. Symposium on Self-Improvement of the Teacher.
2:00 P.M. Symposium on Improvement of Teaching.

Saturday, July 23

9:00 A.M. to Noon. Structural Mechanics. M. S. Ketchum.
P.M. Recreation.

Monday, July 25

9:00 A.M. The Use of Mechanical Ideas in Electricity. W. S. Franklin.
10:30 A.M. Dynamics of Connected Bodies. J. E. Boyd.
2:00 P.M. Project Assignment: Design of Simple Apparatus for Use in Illustrating Principles of Mechanics.

Tuesday, July 26

8:00 A.M. The Gyroscope. W. S. Franklin.
9:00 A.M. Moments and Deflections of Closed Rings. J. E. Boyd.
12:00 Noon. Adjournment.

Evening Meetings

Tuesday, July 5. Smoker.

Tuesday, July 12. Lecture: The Engineer and Public Relations. L. W. Wallace, Executive Secretary, American Engineering Council.

Thursday, July 14. Lecture: The Importance of the Unpractical. John C. Parker, Vice President, Brooklyn Edison Company.

Friday, July 15. Lecture: Opportunities for Teachers of Mechanics. C. F. Scott, Chairman, Board of Investigation and Coordination, S.P.E.E.
Recital on cello and piano. Vladimir Karapetoff.

Monday, July 18. Lecture: Engineering Education and the Social Order. W. E. Wickenden, Director of Investigation, S.P.E.E.

Friday, July 22. Lecture: University Development in Europe and the United States. Parke R. Kolbe, President, The Polytechnic Institute of Brooklyn.

Saturday, July 23. Subscription dinner. Professor Emeritus Irving P. Church, guest of honor.

Monday, July 25. Lecture: What the College Has Done for the Engineering Graduate. R. E. Doherty, Consulting Engineer, General Electric Company.

Wednesday, July 6. Morning Session

The first meeting of the school was called to order by the Director, Dean Dexter S. Kimball. After welcoming the members in the name of Cornell University and of the Society for the Promotion of Engineering Education, Dean Kimball introduced as the first speaker H. P. Hammond, Associate Director of Investigation, who spoke on the subject "The Purposes of the Summer School for Engineering Teachers."

In acting as spokesman for the Board and Staff of the Society's investigation, Mr. Hammond briefly outlined the reasons for the establishment of the summer school and described the principles and methods which would be followed in conducting it, so that those attending might clearly understand the type of work contemplated. The enterprise, he stated, would be more in the nature of a conference than of a school in the usual meaning of that term; no pronounced distinction between members of the conference on one hand and members of the teaching staff on the other would be observed; and the members of the group would be expected to participate actively in the conduct of the meetings.

Reviewing the origin and development of the summer school plan, he described the various steps and negotiations which preceded its establishment, and outlined the plan of organization and the division of responsibility among those directing it.

He then spoke of the fundamental purpose of the enterprise as "the improvement of methods of teaching the fundamental subjects of engineering curricula" and gave the reasons which prompted the selection of mechanics as the

first subject to be considered. Emphasis was given to the thought that study of teaching methods rather than review or study of subject matter should constitute the major portion of the work.

The substance of Mr. Hammond's further remarks, in which the work to be done was described in some detail, is given in the first chapter of this bulletin and need not be repeated.

Following this introductory address, the committee organization of the members was announced as follows:

COMMITTEE ON PROGRAM (to meet with the staff as a general committee on arrangements):

N. C. Riggs, *Chairman*,
P. G. Laurson,
J. E. Lothers,
W. J. Risley.

ENTERTAINMENT COMMITTEE:

K. D. Wood, *Chairman*,
T. F. Hickerson,
E. V. Howell,
H. W. Leet,
I. H. Prageman,
E. P. Slack.

COMMITTEE ON RECORDS:

C. L. Walker, *Chairman*,
Z. R. Bliss,
J. W. Breneman,
W. D. Emerson,
F. E. Holmes,
J. B. Jones,
J. S. Lambie,
G. H. MacCullough,
H. W. Merritt,
A. P. Richmond,
H. A. Schaeffer,
F. B. Schell,
F. N. Weaver.

Wednesday, July 6. Afternoon Session

Dexter S. Kimball: THE PLACE OF THE STUDY OF MECHANICS IN THE ENGINEERING CURRICULUM.

In discussing the place which the study of mechanics should occupy in engineering education, Dean Kimball stated that he would first consider the kinds of problems involving the principles of mechanics which engineers are called upon to

solve and from that outline the scope and purposes of instruction in mechanics and the place which the subject should occupy in the curriculum. He stated that it would also be his purpose to consider some of the limitations of the theoretical aspects of mechanics when applied to practical problems involving indeterminate factors, and to discuss how such limitations should be reflected in the methods employed in the classroom. In illustrating these points the field of machine design was selected as furnishing good examples both of the ways in which mechanics is applied and of the limitations which confront the designer when he is called upon to apply its principles.

Dean Kimball then proceeded to develop these ideas by illustrative problems and by discussion of the methods and procedures followed in designing machines. He spoke in particular of the elements common to all machines, namely, the power element, the linkage element, and the element which accomplishes the machine's purpose. The applications of the principles of mechanics to each of these elements were brought out very clearly. Attention was given to the problems involved in study of the "energy flow" through the machine and particularly to frictional resistances which involve factors difficult to analyze and express in quantitative terms. Limiting factors which influence design were discussed and the statement made that students of mechanics should be given some conception of the difficulties which are encountered in applying principles to actual problems.

Dean Kimball then spoke of recent developments in the field of machine design, such as high rotative speeds, great weight of parts, and complexity of mechanisms as requiring extensions of elementary principles and the development of new methods of analysis. In mentioning these matters, he stated that it was not to be assumed that the undergraduate student should make a thorough study of all of them, but that the teacher should be informed concerning them and at least make the student aware of their existence.

In conclusion, Dean Kimball referred to the illustrations

drawn from the field of machine design as indicating the direct relationship which exists between the study of mechanics and the solution of many of the most common as well as some of the most difficult problems of engineering practice. From this, he said, the inference is plain that mechanics is preeminently the subject of engineering curricula in which the student should receive the most thorough sort of training.

J. E. Boyd: The Plan and Program of the Summer School.

Following Dean Kimball's paper, Professor Boyd addressed the conference as spokesman for the instructing staff and explained in some detail the purposes of the various parts of the program and the methods to be employed in conducting them.

He first mentioned the so-called special lectures, scheduled for Wednesday and Saturday mornings, and said that they were intended to show the relationship of the subject of mechanics to other divisions of the curriculum and to indicate lines of further study which the teacher may profitably pursue. He then referred to the provision for recreation on Wednesday and Saturday afternoons and said in part: "One of the best things you will derive from this school will be an elbow-to-elbow knowledge of the personalities, the ideas, and the aspirations of some forty men from widely separated points. The committee which arranged for these schools had this important by-product in mind. The afternoons scheduled for recreation are as much a part of the program as the forenoons devoted to lectures."

Professor Boyd then took up the major portion of the program, which, he said, was to be devoted to specific discussion of teaching methods in mechanics. He stated that the purpose would be to develop improved methods of teaching a fundamental subject of the curriculum and that the discussion would be centered on the more important parts of that subject. He explained that the demonstration method of

teaching which it was proposed to employ in part could not be an exact copy of ordinary classroom work, but that the effort would be to demonstrate the important principles of good teaching and to discuss methods of classroom instruction. In certain sessions the attempt would be to show how fundamental principles may be presented, in others it would be assumed that the principles had been mastered and attention would be devoted to the application of the principles to real problems.

Developing this idea, Professor Boyd stated: "I have said we shall assume that the principle has been mastered. I should have said that we shall assume that the student has studied the principle, can give its derivation, and thinks that he knows its meaning. No one has really mastered a principle until he is able to make a quantitative application of it to a great variety of apparently dissimilar problems, until he senses its physical meaning, and can recognize it under many disguises. It is easy to state and apparently to know that when a body is in equilibrium under concurrent coplanar forces, the force polygon closes. It is easy to derive from this that the sum of the components of the forces along any direction is zero, and that the sum of the moments about any point is zero. So much for the science; but the art is equally important. Shall we take resolutions, write moments, or employ a graphical method? If we take resolutions, along what axis shall we resolve? If we write moments, what points shall we choose as origins? If we combine moments and resolutions, what precautions must we take in order that the equations may be independent? All these are involved in the art of mechanics as applied to one simple principle, and the principle is never fully understood until these applications are made.

"But the student may make these applications of the principle with skill and certainty when the problem is explicitly stated, and yet fail when he comes to a real structure. He may calculate the moment arms from a problem in a book and not recognize any moment arms in a derrick, a shovel,

or a wheelbarrow which stands before him. As instructors of mechanics we must give him a start in this direction. But we should not teach subject matter in advance of that which is being considered at the time; that is, we should not attempt to teach machine design, structural design, etc., since the students are not ready for the work and will not appreciate it. If we start students right, the instructors of structural engineering and machine design will continue the work of training them to connect simple principles with real engineering problems of greater and greater complexity."

In conclusion Professor Boyd outlined the plan of dividing the group for seminar and conference meetings and explained how two of these meetings, to be devoted to project assignments, would be conducted, and indicated the advance preparation required.

Professor Boyd mentioned that a shelf was provided in the central meeting room, on which selected reference works in mechanics were to be found, and urged the members to consult them.

Wednesday, July 6. Evening Meeting

A smoker was tendered to the members of the conference by the faculty of the College of Engineering of Cornell University.

Thursday, July 7. Morning Session

W. S. Franklin: Teaching the Fundamentals of Mechanics.

At the beginning of the first of three periods devoted to this subject, Professor Franklin discussed the necessity of making fundamental definitions of physical laws very explicit. He said that every statement of principles or laws and every definition of mechanics rightly understood is an actual operation, "something done with the hands." As an illustration he stated that the term *weight* as used in everyday life means precisely the same thing as the term *mass* and said that the mass of a body was rightly defined by the opera-

tion of weighing the body on a lever scale. He next stated that any definition or statement of principle in mechanics, when framed so as to suggest clearly its operational aspect, will meet with the approval of the most critical of laboratory men, and the laboratory man is the final arbiter in physics.

Emphasis was laid upon the necessity of explaining every fundamental concept in terms which the student can understand in the light of his own experiences. Illustrations were given by citing numerous examples of forces, sets of forces, action, reaction, etc., in terms of commonplace occurrences. He then stated that a force can be exerted upon a body only by another body which is in actual contact with it, the only exceptions being the force of gravity and electromagnetic forces, in which cases "nobody has ever seen the rope." From this he proceeded to consideration of the *free body method* of analyzing forces, which was introduced by Church, to illustrate the point.

Considering in turn a number of fundamental concepts of mechanics, Professor Franklin discussed action and reaction and stated that it is a remarkable fact that many teachers of mechanics have wrong conceptions of the equality of action and reaction. "Why," he asked, "if action and reaction are always equal and opposite, do they not always balance each other? Because they act on different bodies, and two forces must always act on the same body if they are to balance each other." "Is it," he asked, "an example of action and reaction to state, 'a man sitting on a chair pushes downwards on the chair, and the floor pushes upwards on the chair?' It is not; the reaction of the downward push of the man on the chair is the upward push of the chair on the man." This matter, he stated, is of vital importance and no one who does not have it straight can know mechanics.

Professor Franklin continued his discussion by considering Newton's first law of motion, balance of forces, friction, and work and energy. In speaking of the unsatisfactory nature and indefiniteness of certain phrases used by teachers of mechanics, he gave as an example the statement often used,

"work is done when a force moves a body." As a substitute for this, he would give the more exact statement, "whenever a body on which a force acts moves in the direction of the force, work is done and is equal to the product of the force and the distance that the body has travelled in the direction of the force." He especially criticized the definition, "work is equal to force times the distance through which it acts," and stated that this was likely to be misunderstood, as in the case of a one hundred-pound force exerted at the end of a stationary rope ten feet long.

Continuing the discussion of the teaching of fundamentals of mechanics, Professor Franklin considered translatory displacement, center of mass, rotary motion, velocity, and acceleration.

He then took up the matter of systems of units to be used in teaching mechanics and stated that the Educational Committee of the American Physical Society had reported in favor of the English system of units, there being no other basis for agreement between physicists and engineers than this plan. He stated that the use of this plan involves the recognition of only five points by the engineer, namely, (*a*) that the word *weight* as used in everyday life has exactly the same meaning as the word *mass;* (*b*) that the lever scale measures mass or weight, so that the *weight* thus obtained can not be divided by "g" to give mass; (*c*) that the lever scale does not yield the weight of a body in the force sense; (*d*) that we agree to use the pull of the earth on a one-pound body at 45° N. Latitude and at sea level for our unit of force; and (*e*) that we need a name for the amount of material which will be accelerated at the rate of one foot per second by an unbalanced force of one pound. Professor Franklin advocated the use of the term "pull-pound" to indicate the unit of force.

Thursday, July 7. Afternoon Session

The first few minutes of the meeting were devoted to a brief general discussion of Professor Franklin's paper of the

morning meeting. The conference then divided into three seminar groups for further discussion.

Seminar Group 1. **W. S. Franklin, Leader.**

The discussion centered largely upon systems of units in mechanics and the teaching of fundamental concepts and laws. In answer to a question, Professor Slack described his method of presenting work and energy to beginning students of mechanics. His presentation of the subject is taken up in the following steps: (*a*) fundamental definition of work; (*b*) illustration of the work done in moving a body on a horizontal plane; (*c*) illustration of work done in moving a body up a slope; (*d*) the study of units of work both in the "c.g.s." and English systems of units; and (*e*) an introduction to the study of power.

A general discussion by the members followed. The meeting concluded with explanations concerning the project assignment for July 11, the *Devising Problems in Statics.*

Seminar Group 2. **E. W. Rettger, Leader.**

Before taking up the discussion of the subject matter of the lecture of the morning attention was devoted to laboratory work as an adjunct to the teaching of mechanics. Professor Rettger pointed out that students acquire facility in applying abstract principles and gain mastery of subjects studied from texts if they see, or conduct, experiments in which the principles are applied to actual physical situations. From this he concluded that laboratory experiments and demonstration lectures form a valuable adjunct to classroom recitations. Attention was devoted to the technique of laboratory work in mechanics including reports, apparatus, and the scheduling of tests so that the student performs experiments relating directly to the portion of the subject which he is studying at the time.

Discussion then turned to the points covered by the lecture of the morning with particular attention to methods of presenting fundamental laws of mechanics and to ways of clearing up points which usually give difficulty to students.

Seminar Group 3. **J. E. Boyd, Leader.**

The discussion was opened by Professor Boyd who suggested the value of experimental demonstration and verification of fundamental laws. Such tests, he stated, need not be complicated but may on the contrary often be quite simple and within the scope of the student's personal experiences. As an illustration he described an experimental method of demonstrating the laws of acceleration by the measurement of the "pick-up" of an automobile. Professor Boyd stressed concentration on thought processes rather than the use of formulas. The rest of the period was devoted to the discussion of points brought out by Professor Franklin in his lecture of the morning.

Friday, July 8. Morning Session

E. W. Rettger: HISTORY OF MECHANICS BEFORE NEWTON.

Professor Rettger's paper is printed in full in Part IV.

W. S. Franklin: TEACHING THE FUNDAMENTALS OF MECHANICS.

Professor Franklin concluded his consideration of methods of teaching the fundamentals of mechanics, begun on the previous day, and, during the latter part of the hour, began a presentation of the mathematical analysis of mechanical wave motion, a topic which he proposed to develop more fully at a later meeting.

Consideration was given to teaching fundamental concepts of dynamics. Professor Franklin re-emphasized the importance of presenting fundamental concepts in terms which come within the range of the student's own experience. As an illustration, he stated that the teacher might consider the case of an automobile starting from rest on level ground. Such questions as what starts the automobile; how are the forces exerted; if the ground pushes forward on the wheels, how is the force exerted; may be taken one by one and the fundamental concepts of dynamics illustrated in such a

way that the student may be led to a clear visualization of their meaning. He suggested, in connection with this illustration, the use of sketches showing the forces acting, and finally the solution of numerical problems in order to fix the concepts in the student's mind and to show quantitative relationships.

The remainder of the session was devoted to the study of wave motion. The following topics were considered: oscillatory and wave motion; the equation of a traveling curve; the principle of superposition; undetermined constants in the solution of ordinary differential equations; undetermined functions in the solution of partial differential equations; the differential equation of the transverse motion of a stretched string; pure wave on string traveling to the right; pure wave on string traveling to the left; obtaining of solutions of the differential equation of such form that the initial and boundary conditions are satisfied; the motion of a plucked string; and the behavior of a rod which strikes endwise against a rigid wall.

Saturday, July 9. Morning Session

Vladimir Karapetoff: Applications of Mechanics to Electrical Engineering.

Professor Karapetoff distributed copies of a classified list of applications of principles of mechanics to electrical engineering. He stated that the list should not be considered as an outline of what electrical engineering students should be taught in mechanics but merely as a list of topics with which he and his co-workers had come in contact in thirty years of experience. He stated that the topics were not listed under the customary designations employed in mechanics, as moment of inertia, work and energy, etc., but under headings covering the several fields of electrical equipment. He suggested that the list might be rearranged by teachers of mechanics under such a grouping as would represent the several sub-divisions of the subject of mechanics.

Professor Karapetoff's list, together with his comments on certain items, follows.

Electrical Machinery

Shafts subjected to a combination of torsion and flexure.

Critical speeds and whirling of shafts.

Unbalanced magnetic pull as an additional load on the shaft.

Mechanical stresses in revolving field poles, dovetails, etc.

Strength of revolving disks, solid and with holes.

Torque, speed, power, and energy in various units.

Retardation tests on electrical machines.

Expressions for the moment of momentum and stored energy of rotation.

Centrifugal governors of hydroelectric units and their theory.

Hunting of synchronous machines; reduction of a machine to a pendulum; equivalent inertia, restoring force and damping.

Noise and vibration of machinery.

Natural frequencies and harmonics of vibrating bodies.

Mechanics of lubricating oils and of bearings.

Motion of air and other gases used for cooling.

Transmission Lines

The curve form of a conductor in a span.

Supports on equal and unequal heights; effect of temperature.

Stresses in an aerial conductor due to its weight, sleet, and wind.

Secondary stresses in special conductors, such as steel-core aluminum cables, duplex conductors, hollow-core conductors, hemp-core conductors, etc.

Stresses in a messenger cable supporting an electrical cable at intervals; double and single catenary construction; tie-off on curves.

Stresses in steel towers, concrete poles, and wood poles, with and without wind.

Unbalanced pull when one or more of the conductors is absent.

Stresses in the foundations for towers.

Stresses in crossarms, insulator pins, etc.

Electric Railways

Train resistance, its elements and their variation with the velocity; acceleration and speed-time curves. Braking.

Energy input on acceleration. Energy storage in the parts moving in a straight line and in the revolving parts. A pendulum as an acceleration meter.

Electric locomotives; suspended and non-suspended weights, link motions, connecting rods; their unbalanced forces and stresses; influence of the position of the center of gravity.

Mechanical Forces Due to Magnetic Fields

The magnitude of these forces is most conveniently derived on the principle of virtual displacements, and this principle can be best explained on a system of material points or on an elastic girder under load, so as not to complicate the treatment by electromagnetic quantities.

Busbars through which alternating currents are flowing behave like uniformly loaded beams and also vibrate at the synchronous frequency or a multiple thereof.

Electromechanical Applications

Belting, rope, gears, silent chains, etc.; properties of springs.

Energy storage in large adjustable-speed driving motors used in steel mills and with mine hoists.

Starting and stopping of elevators and cranes.

Communication Engineering

Laws of vibration of diaphragms in telephone transmitters and receivers. Nodes of harmonics; vibrational impedance.

Acoustics of buildings, resonating chambers, horns, etc.

Properties of sound waves.

Speech analysis.

Galvanometers and Oscillographs

Study of the motion of the coil in a ballistic galvanometer, as an example of a damped pendulum. Effect of the moment of inertia, torsion constant of the suspension, air friction, eddy currents, etc.

Laws of vibrating strings, resonance.

Waves and Oscillations

An understanding of electric waves and oscillations is much facilitated by a previous study of mechanical waves and oscillations.

The following topics would help in particular: theory of the pendulum, resolution of an irregular periodic motion into harmonics; resonance and near-resonance; wave-motion in solids and gases; velocity phase and pressure phase; water waves in pipes and in open canals; different kinds of reflection.

Vector Analysis

Vector analysis plays an increasingly important part in electrical engineering and in adjacent branches of electrophysics. Its principles can be best learned in mechanics; first, because it is wonderfully effective there, and secondly, because the student deals with more tangible applications than with electric vectors. Coffin's *Vector Analysis* and Silberstein's *Vectorial Mechanics* are recommended to teachers who wish to familiarize themselves with the method. The following topics are of particular interest, as leading to corresponding electrical subjects:

Differentiation of vectors in deriving components of acceleration of a material point along a curved path;

Gradient and potential, in application to gravitation;

Concept of divergence, explained in application to hydrodynamics;

Curl explained in application to translation and rotation of a rigid body and to vortex formation in a liquid.

General equations of hydrodynamics of a perfect velocity potential, conjugate functions, and mapping of lines of flow in two-dimensional problems.

Theory of Elasticity

The general method of treatment used in the theory of elasticity is useful in the study of electrostatic and magnetic fields, preparing the student's mind both from physical and formal mathematical points of view.

General Laws of Motion

Modern electronics is built essentially upon classical laws of motion of material points and rigid bodies, these laws being modified by the quantum hypothesis.

The following topics are useful in understanding modern works on the structure of matter:

Laws of motion of planets around the sun, because of their application to the structure of the atom.

General laws of motion under the influence of attractive or repelling centers.

Flight of a projectile subjected to various forces; application to moving ions and their deflection by electric and magnetic forces.

The gyroscope and its precession; this finds an application in the theory of atomic spectra.

D'Alembert's principle and analytical expression of con-

straints. Fundamentals of calculus of variations and the principle of least action.

Lagrangian equations of motion and the Hamiltonian canonical form of equations; theory of astronomical perturbations and its modification in the theory of a complex atom.

STATISTICAL MECHANICS

In ionized gases and liquids, we have to consider a large number of discrete particles endowed with different velocities. They are dealt with according to the principles of the so-called statistical mechanics, which is a rapidly growing science, auxiliary to atomic physics. The best introduction into the subject is the classical kinetic (or dynamical) theory of gases, with its considerations of distribution of velocities of particles, probabilities of various kinds of collisions, elastic and inelastic, viscosity, Brownian movements, motion of a sphere in a medium consisting of bombarding particles, etc.

A useful topic is also that of partition of energy among various degrees of freedom of a mechanical system. This later leads to the principle of equipartition and to its failure in certain cases, thus preparing the student's mind to the quantum theory (or jumpwise changes in energy), with its applications to the problems of conduction, radiation, specific heats, etc.

Saturday, July 9. Afternoon

Trips of inspection of the University campus and the various buildings were arranged by the program committee, each group being conducted by a member of the Cornell faculty familiar with the location.

Monday, July 11. Morning Session

J. E. Boyd: EQUILIBRIUM OF CONCURRENT CO-PLANAR FORCES.

In opening his presentation, Professor Boyd stated that he would use the above topic as an example of teaching methods in presenting the principles of statics to a class. Since he would deal with the art of teaching, he proposed to present his subject as nearly as possible as he would in an actual classroom, believing that methods could be exemplified better by an illustrative demonstration than by a description.

The subject matter to be presented is covered by articles 43 to 50 inclusive, of *Mechanics* by Boyd. It was assumed that the student had previously mastered articles 41 and 42, and had learned to make space diagrams of concurrent forces in equilibrium, and understood the meaning of the term equilibrant.

Professor Boyd chose the following problem as an example:

> A mass of 20 pounds is supported by three cords in the same vertical plane. One cord is horizontal toward the right and exerts a pull of 5 pounds. The second cord makes an angle of 25° to the right of the vertical. The third cord makes an angle of 42° to the left of the vertical.
>
> Find the unknown tensions.

He then demonstrated the solution of this problem by three methods: (*a*) graphical solution; (*b*) solution by resolutions; (*c*) solution by moments. In applying these three methods, the purpose was not only to drill the class in the several methods of solution, but also to furnish independent checks of the results. Professor Boyd stated his belief that students should be trained to check their work by independent methods wherever possible.

Graphical Solution.—Professor Boyd explained that he used graphical methods freely in teaching the fundamentals of statics and that he made it a practice to require students to do as much of the work in the classroom as possible. To that end he usually has one or more students working at the board. By questioning, he presents the topics through these men to the entire class so that all members may benefit by the discussion. He stated his preference for accurate quantitative methods wherever possible, even in graphical solutions. To that end he explained a number of expedients which he employs in having students solve problems graphically at the blackboard, using scales and squares to lay out vector quantities.

Members of the group were then called upon to act as "students" and the solution of the problem stated above was demonstrated through them.

Solution by Resolutions.—Solution of the same problem by the method of resolutions was then demonstrated in the same manner, Professor Boyd acting as instructor and bringing out the various points in the solution by questioning the members working at the blackboard.

Solution by Moments.—In solving the problems by the method of moments, any point on the cord extending to the left was chosen as the center and perpendicular distances to the lines of action of the two known forces and the line of action of the unknown force were scaled from the space diagram previously constructed. The unknown force was then determined from the equation of moments. The remaining unknown force was obtained in a similar manner, taking the center of moments in the line of action of one of the other forces.

Throughout the session Professor Boyd stressed certain ideas: the use of angles other than 30, 45, and 60 degrees, for the sake of training in computation; calling upon members of the class to perform all of the operations incident to the presentation of a subject rather than having this done by the instructor himself; the use of commonplace tools in quantitative graphical solutions; and the desirability of checking the results by several methods in order both to provide drill in those methods and to train the student to work accurately.

E. W. Rettger: THE HISTORY OF MECHANICS; NEWTON AND HIS SUCCESSORS.

Professor Rettger's lecture was a continuation of the one delivered on July eighth and covered the history of mechanics from Galileo to the time when the science was well established. Space limitations do not permit of the publication of Professor Rettger's lecture in full but a copy is available in the office of the Director and a reading of it will reward any one interested in the history of the subject. The following is a brief digest.

Referring to the work of such eminent men as Descartes, Euler, Napier, Leibnitz, and others, Professor Rettger spoke

of the frequency with which discussions of science were based on theological grounds and in this connection dwelt briefly on the influence of religion in the development of the science.

Continuing the discussion of eminent discoverers in mechanics, reference was made to the contributions of Huygens, namely: principles concerned with centrifugal force; completion of the theory of the pendulum, and the determination of the acceleration due to gravity by means of the pendulum; the theory of center of oscillation of a compound pendulum; the invention of the pendulum clock; and theories concerning elastic impact.

The contributions of Newton to the science of mechanics were then discussed. In summary of the influence of Newton's work, the speaker said, "Clearly to define the concepts of force, mass, and momentum, and clearly to formulate the three laws known as Newton's laws of motion, was an achievement in itself; but to see that these concepts and laws were all that was needed as the starting point of the whole science of mechanics required a power of analysis that has been given to but few people in this world. Before Newton mechanics was disconnected and unorganized, each problem requiring a volume by itself and the solution of this problem depended upon devices and assumptions, many of which seemed entirely independent of the devices and assumptions that had to be made in connection with another problem. Newton, however, brought order out of chaos and reduced mechanics to a system so that everything fits in its proper place."

Professor Rettger gave an interesting resumé of the life of Newton and of his discovery of the law of universal gravitation, his invention of the calculus, and his other contributions to the science of mechanics.

His lecture concluded with a discussion of the contributions of Euler, D'Alembert and Lagrange.

Monday, July 11. Afternoon Session

Before dividing into seminar groups there was a brief general discussion, under Professor Boyd's leadership, of his lecture of the morning. Attention was devoted chiefly to graphical methods.

Seminar Group 1. **J. E. Boyd. Leader.**

Each member of the group submitted several sets of problems representative of the type used by them in teaching the subject *non-concurrent co-planar forces.* Several of the members placed their problems on the blackboard and explained their classroom methods.

In opening the discussion, Professor Boyd suggested that problems contain sufficient work to be instructive but that they should not be so complex or difficult as to consume an undue amount of time. Continuing the discussion, Professor Laurson advocated the practice of stating a good many problems in words without illustrative diagrams and requiring students to prepare their own diagrams and thus to visualize the conditions of the problem.

Problems were presented by Messrs. MacCullough, Hudson, Jones, Leet, Lambie and Laurson, who illustrated the type of problems employed and the methods of instructing students in their solution. Attention was given to the amount of time which students should be expected to spend on a day's assignment. It was generally felt that one hour on problem solution was sufficient and that the remainder of the time should be devoted to a study of the text. It was felt by some that an occasional problem should be given with superfluous or redundant data in order to teach the student to discriminate. The question as to how much collaboration between students should be permitted was discussed. The group also considered the relative weight which should be given to homework in preparing term grades. Certain of the members do not consider grades for home work in pre-

paring term marks. Others give some credit and only a few give any considerable credit.

Seminar Group 2. W. S. Franklin, Leader.

The group considered the same topic as Group 1. Illustrative problems were submitted by Messrs. Wheeler, Schell, Simpson, Risley, Repscha, West, Slack, Richmond and Weaver. The discussion centered around the various methods employed in training students in the solution of problems and in overcoming their difficulties. Considerable attention was given to the matter of drill in the making of clear and accurate sketches as a necessary part of the solution of problems in mechanics.

Seminar Group 3. E. W. Rettger, Leader.

Illustrative problems were presented by Messrs. Conley, Bullard, Holmes, Gilmour, Dyble, Breneman, Emerson, Barclay, Hickerson, Bliss, Evans, and Butler.

After considerable discussion the following points were agreed upon by the group in connection with problem work in statics: (1) Problems should not involve complicated solutions; the teacher of mechanics should spend his time on principles and not in teaching mathematics. (2) The status of mechanics as a preparation for design courses should be emphasized. (3) Problems of a practical nature should be employed. (4) Problems capable of experimental verification are desirable.

Tuesday, July 12. Morning Session

J. E. Boyd: EQUILIBRIUM OF NON-CONCURRENT CO-PLANAR FORCES.

The first half of the morning session was devoted to presentation and discussion of methods of teaching the above division of statics. Before taking up the assigned subject Professor Boyd re-emphasized the principle mentioned in his previous lecture, namely, that of having as much of the work as possible in class done by the students themselves at the

blackboard with the instructor guiding the work and bringing out the subject matter by suitable questions. He stated, however, that he does not follow this method invariably but frequently divides the class, sending part to the board and having the others remain at their seats. The entire class is then divided into several groups and different problems assigned to each group. Upon completion of the problems they are analyzed and discussed.

Turning to the subject of his lecture, Professor Boyd suggested first a brief review of the important facts and principles connected with the study of this division of statics. To illustrate, he sketched a number of forces upon the board and described the solution of the problem by the following method: First assume that any force may be regarded as applied at any point in its path and that any two forces whose paths intersect are concurrent. On this basis obtain the resultant of the first two forces assumed as concurrent. Next combine this resultant with another force, obtaining a second resultant; and so on until the final resultant is obtained.

Emphasizing again the necessity of checking solutions, Professor Boyd suggested that the magnitude, position and direction of the resultant be obtained algebraically by summation of the x components, summation of the y components, and summation of the moments of all of the forces, these summations in each case being equal to zero. He also suggested checking the work by means of the force polygon. Professor Boyd then demonstrated how the assigned subject would be presented to a class and concluded the demonstration with the solution of illustrative problems.

E. W. Rettger: A Method of Conducting Classes in Mechanics.

In opening his remarks Professor Rettger stated that in response to several requests he would explain the methods of teaching mechanics which had been developed at Cornell University by Professor Irving P. Church.

He first spoke of the assistance given to teachers beginning the work of classroom instruction. Each beginning teacher is provided with a complete outline or syllabus of the course, including all of the text assignments, illustrative problems, and even the solutions of these problems. The instructor is not required to follow a prescribed method *in toto* but is not expected to make material alterations. As he gains experience it is expected that he will modify his practice to suit personal preferences. The effect, however, of rather close supervision at the start is to mold teaching methods largely to a common plan. Professor Rettger expressed the belief that much more might be done than at present to guide young teachers and mentioned the experience cited to him by many of being left entirely to their own resources.

Passing from the matter of aid and guidance of the younger teachers, Professor Rettger outlined the method of conducting classes. He first described the work of the second half of a recitation period in which half of the class is sent to the board and the other half solves a problem at their seats. Those sent to the board are handed small cards on which are designated either some theory to be developed or some problem to be solved. He emphasized the fact that every student is expected to be able to deduce the formulas of the assignment. The assigned problems refer either to the lesson of the day or to that of the previous day so that each lesson is covered once as advance and once in review. During this part of the hour, the instructor devotes his attention to the students working at the board, confers with each of them concerning his assignment, points out difficulties, and guides them without giving undue aid. The seat problems are collected at the end of the hour. At the beginning of the next recitation period, the problems collected at the end of the previous hour are returned with mistakes noted and assigned grades indicated. The instructor then solves the seat problem at the board and explains it with running comment. Questions raised by students are answered and parts of the day's assigment which give difficulty are explained. The division of

the class into those working at the board and those working at their seats is then made and the process previously explained is repeated.

Frequent examinations are given during the term, each including both the theory and the problems covered since the previous examination. The last week or so of the semester is devoted to a general review of the subject and includes problems of some magnitude, the theory being taken up only as far as necessary to explain the problems. The final examination consists largely of problems selected so as to involve principles drawn from several parts of the subject.

Professor Rettger explained that it is a principle not to give more assistance than is necessary and that he believes "the only mechanics worth knowing is that you dig out for yourself." This he believes to be sound pedagogy. He feels that many teachers are prone to give more assistance than necessary and "to do the students' thinking for them."

Passing from the methods developed by Professor Church, Professor Rettger considered the question of arousing the student's interest in his work. He stated that when a class becomes interested in mechanics, half of the teacher's difficulties are solved. He then illustrated methods of arousing interest by the selection of interesting and rather unusual problems. Professor Rettger stated his belief that each instructor must to a large extent select the method which he prefers but that the essential features of the plan employed in any department of an institution may well be worked out in accordance with certain general principles accepted alike by all teachers in the department.

Professor Rettger considered the problem of how students may be induced to work independently and stated that the solution of problems in the classroom is a means of avoiding copying. He felt that students may often work together to advantage but that this practice should not be permitted to go too far.

Tuesday, July 12. Afternoon Session

The early part of the afternoon session was devoted to a presentation of the manner in which mechanics is taught in their classrooms, by Professors S. G. George, W. R. Cornell and K. D. Wood of the Cornell faculty. This was preliminary to subsequent visits by members of the conference to the regular undergraduate summer classes in mechanics then in session.

Professor George stated that the methods now employed in Cornell are based largely upon those developed by Professor Irving P. Church, and spoke of Professor Church's practice of assembling all of the sections of the class once each week in a single group, and lecturing to them on some portion of the work, in order that all of the students might come under his instruction. Attention was then given to the computation periods which are provided in the course in mechanics. These periods are scheduled for two and one-half hours each week and are devoted to the solution of problems of some magnitude. The course is also accompanied by an auxiliary laboratory period of two and one-half hours each week. Analytic mechanics is taught during the first semester and mechanics of materials during the second semester. Speaking of the individual teacher, Professor George felt that each man should be permitted to follow his own methods since the experienced teacher could describe but could not transmit his methods to others. He believes that one of the first requisites of good teaching is the putting of energy into the work. To develop the student's own ability, he suggested that each student be required to do some work in the classroom at each class meeting, either blackboard work or seat work. He also believes that the students should be assigned home problems. He then referred to a practice in vogue at one time at Cornell of conducting a course called "Engineering Calculations," which was given with the purpose of correlating the work in mathematics with that in the engineering subjects. In answer to questions, Professor George stated that the course in calculations was given in the sophomore year and that it was an at-

tempt to give the men a physical concept of mathematical principles.

Professor K. D. Wood outlined the methods of conducting class work in mechanics for the students of mechanical and electrical engineering. He presented a syllabus indicating the scope of courses in mechanics and mechanics of materials and mentioned the following teaching procedures which are employed: occasional lectures, oral quizzes, demonstrations, supervised written work at the board and at the seats, written quizzes and final examinations. No set order is followed in the recitations and any class hour may be devoted to a combination of the elements above enumerated. No recitation is started with a quiz but usually consists of a discussion of the day's assignment or of that of the previous day. In general, supervised work at the board or seat occupies about forty per cent of the time of the course, demonstrations about forty per cent, and the remainder of the time is devoted to lectures or quizzes. Occasionally, students are requested to grade their own papers in class, basing the grade upon the correct solution which is being presented at the board.

Professor W. R. Cornell made additional comments on the methods employed in the teaching of mechanics to students of electrical and mechanical engineering, devoting most of his time to a description of the methods employed in the computation periods.

After Professor Cornell's remarks, the group divided into three sections for the presentation of teaching methods by members of the conference.

Seminar Group 1. **J. E. Boyd, Leader.**

The meeting was devoted to the demonstration of classroom methods by three members of the group. The first presentation was given by Professor E. P. Slack on the teaching of harmonic motion and Hooke's law. Professor Slack first stated that it was his custom to give opportunity for review of the previous day's assignment by asking if there were any questions and by discussing those asked. After dispos-

ing of this, Professor Slack takes up the assignment of the day. To illustrate his methods he demonstrated the teaching of articles 44 and 45 of Franklin and MacNutt's *Mechanics*. The exercise was opened by the question—what is simple harmonic motion? This was answered by members of the class by giving definitions and by illustrations of simple harmonic motion. The question was then asked as to whether all to and fro motion is simple harmonic motion, to which a negative answer was given. The importance of the study of simple harmonic motion was then pointed out with the statement that no other type of motion appears more frequently in nature, as, for example, in sound and light, and in the realm of electricity.

After the general concept and the occurrence of simple harmonic motion had been discussed, the mathematical treatment was given and the fundamental equations developed. At the conclusion of the demonstration, opportunity was given for criticism and discussion of the method employed.

Seminar Group 2. **W. S. Franklin, Leader.**

The presentation of a method of teaching *principles of virtual work* was demonstrated by Professor W. D. Emerson. He stated that his presentation was based on the method employed in Franklin and MacNutt's *Mechanics* and that the students had been requested to hand in problems 53 to 57 inclusive. At the beginning of the period, Professor Emerson requires each student to supply answers to questions, such as the following, by placing a plus (+) mark if the statement is correct and a zero (O) mark if incorrect:

Name.....

Franklin & MacNutt's *Mechanics*, Art. 20

MECHANICS 197

1. The power which a body stores by virtue of its velocity is called the potential energy of the body.

2. If any body upon which a set of balanced forces acts moves in any direction, the total work done by all of the forces will be equal to zero.

3. A body which is acted upon by a set of balanced forces can not move in any direction.

4. A force which helps the movement of a body is said to do positive work on the body.

5. A weight of w "pounds" which is held on a smooth inclined plane by a force P parallel to the plane may be regarded as moved up the plane a distance S, and raised a vertical distance y, so that

$$-wy = Ps = 0.$$

Professor Emerson stated that he believes the true-false type of question conserves time and enables the teacher to cover a larger portion of the text. He stated that ten minutes are allowed for the answering of the above questions and that the papers are then handed in and corrected at once. The questions employed are of increasing order of difficulty. In grading the questions a correct answer is rated $+1$, an incorrect answer -1. Discussing the above method, Professor Emerson said that one difficulty he experiences is in preparing absolutely accurate statements so as to avoid penalizing the student by deficiencies in wording. He stated that the effect of such questions was to induce the students to read their texts more carefully. In discussion of Professor Emerson's methods, Professor Evans stated as an objection his belief that certain students having facility with what he

termed "a word method" would show up to advantage as compared with those more proficient in the "mathematical method." To meet this objection, Professor Emerson stated that he requests all students to hand in two problems each day in addition to questions similar to the above.

Continuing the description of his classroom methods, Professor Emerson stated that each day's assignment includes a review of the lesson of the previous day. He then proceeded to discuss the main points of the day's assignment and took up the presentation of the subject of virtual work, following the line of reasoning employed in Boyd's *Mechanics*.

Seminar Group 3. E. W. Rettger, Leader.

Mr. K. G. Merriam described his method of teaching the subject *non-concurrent co-planar forces* by the method of sections. Article 65 of Boyd's *Mechanics* was chosen as the day's assignment. Mr. Merriam stated that homework problems are collected at the beginning of each class hour and that general questions relating to the assignment are then answered. A fifteen or twenty minute quiz is given at nearly every meeting of the class. Mr. Merriam described his method of teaching the *method of sections*, taking up first the selection of the free bodies to be considered and the conditions of equilibrium. The method was illustrated by two problems selected from those actually employed in class. In discussion, Professor Laurson asked how the students could be taught to determine whether the stress in a given member is tension or compression. It was felt that it would be best for the student to determine the sign of the stress by inspection and then by computation to determine whether or not he had employed the correct sign.

Tuesday, July 12. Evening Meeting

L. W. Wallace: The Engineer and Public Relations.

The first of six evening lectures by speakers of prominence was delivered by Mr. Wallace, on the above subject. His

paper was concerned primarily with the part which science plays in present-day life and the place which scientific men are assuming in our present social order. Attention was given to the activities of groups of engineers throughout the country and the influence which they may exercise on civic matters. Mr. Wallace concluded by describing the organization of the American Engineering Council and its influence throughout the fields of engineering and public affairs.

Wednesday, July 13. Morning Session

G. B. Upton: THE MATERIALS TESTING COURSE AT CORNELL UNIVERSITY.

Professor Upton discussed laboratory courses in materials testing as an adjunct to work in mechanics and the use of such courses as means of teaching both the principles and the applications of mechanics. As an illustration of how such courses may be made to serve these purposes Professor Upton described the course in materials testing given to students of electrical and mechanical engineering of Cornell University. In the course of his remarks, he not only outlined the general purposes and methods pursued in the course, but also touched upon the specific methods employed and described many interesting features of the experiments conducted.

In introducing his remarks, Professor Upton stated that the intent of the course is to give students a clear conception of the fundamental properties of materials of construction, to indicate how those properties are measured and analyzed, how they are specified and checked commercially, and also how properties originate and can be controlled or modified. The intent is also to bring out the bases and limitations of the ordinary stress and deformation formulas of mechanics for elastic loadings, and the directions and magnitudes of errors in use of "elastic" formulas after the elastic limit has been passed.

Under the plan followed in conducting the course in materials testing, one instructor deals with one group of from

six to eight students only at a given laboratory period. Exercises are assigned at a previous laboratory hour and references to textbooks given. The students then come prepared upon the subject of the experiment and have covered the assigned references in the textbook, which include any mathematical analyses involved. The first hour of the three-hour laboratory period is given over to informal discussion covering first the textbook assignment, then the engineering practice and applications. The latter are not given in the textbook and make the instructor's job a live one. The instructors are trained for this work; each instructor is temporarily a specialist in the topics of his experiment, which he repeats day after day for some weeks, until all the students in the course have had that test in the cycle of assignments.

The second hour or so is given to actual testing work. The instructor operates the machine, leaving the students entirely free to devote their attention to the action of the test pieces and the taking and recording of the observations. Professor Upton believes the students are studying the material under test, not the operation of the testing machine. During the test, discussion between instructor and students is continuous and goes on after the test is completed to cover calculations, curves and report contents. The last half-hour of the period is given to handing back and discussing previous reports.

Reports are written up outside of laboratory hours and consume an average of nine or ten hours each. There are ten or twelve reports in a semester of fifteen weeks, the other weeks being devoted to review, lectures and examinations. Outlines are given out for the topics to be included in each report. They always require discussion of the fundamental principles involved, outlines of mathematical analyses, descriptions of the test pieces and instruments used, description of conduct of the test and phenomena observed, methods of calculation with numerical examples, properly drawn curves, and some discussion of commercial applications. Reports are read by the instructors from the point of view of a person ignorant of the particular subject and learning from the re-

port. Grading is based upon the assimilation by the student of new information offered in the experiment. Errors, misapprehensions, or lack of apprehension send the report back for correction, about two-thirds of them being so returned. Contact between instructors and students is intensive and thorough, despite the handling of large classes by a small staff. It is estimated that with the present scheme, about five times as much ground is covered at no greater expense of the student's time than with the method previously employed.

After outlining the purpose and scope of the course in materials testing, Professor Upton continued by describing the special types of instruments developed in connection with the course. He then discussed the more important features of those experiments which are of primary interest to teachers of mechanics and outlined the fundamental principles which are taught in connection with the tests.

Wednesday, July 13. Afternoon

The members of the conference spent the afternoon in visiting Enfield Falls and Glen under the leadership of Professor O. D. VonEngeln, of the Department of Physical Geography of Cornell University, who pointed out places of geological interest and explained the formations.

Thursday, July 14. Morning Session

J. E. Boyd: THE TEACHING OF CENTER OF GRAVITY AND MOMENT OF INERTIA.

The meeting was devoted to presentation and discussion of methods of teaching center of gravity and moment of inertia, and was conducted as a model classroom exercise. It was assumed that the class assignment was articles 100 to 103 inclusive of Chapter 14 and article 147 of Chapter 15, of Boyd's *Mechanics*.

In opening the meeting, Professor Boyd suggested that a sample problem be selected as an illustration and that the

methods of determining centers of gravity and moments of inertia be taught from their applications to concrete cases. As a first illustration, Professor Boyd selected a triangle and showed how the center of gravity would be located by use of the calculus, demonstrating how the element of area would be selected, and indicating how the expressions to be integrated would be set up, the limits of the integrations selected and the integrations performed. Professor Boyd commented that he usually required students to obtain results by two independent methods both to serve as a check and to illustrate that different solutions were possible.

After the solution of the first illustrative problem Professor Boyd suggested that a somewhat more difficult one be assigned. This he illustrated by selecting an area bounded by the curve $x^2 = 4y$, the x axis, and the line $x = 9$. In solving this problem, Professor Boyd stated that he would first ask for the determination of the location of the center of gravity using a vertical element of area, and later using a horizontal element of area. There was some discussion of the mathematical steps involved and particularly of the designation of the limits of integration and the proper time in the solution for the introduction of the limits.

Professor Boyd indicated that the two problems selected were the first of a group designed to bring out the principles of center of gravity and moment of inertia and that the entire group were in an increasing order of difficulty.

In closing his discussion, Professor Boyd outlined the methods he employs in presenting the solutions of other problems on this general subject.

E. W. Rettger: WORK AND ENERGY.

In introducing the discussion of work and energy, Professor Rettger first referred to the historical development of this division of mechanics, stating that Huygens first introduced the concept of "vis viva" or of *kinetic energy*, while Descartes accepted Galileo's view and held that *momentum* was the measure of active force in a body. There were thus

two schools of physicists, the Cartesian, and the Liebnitzian, Liebnitz having accepted the views of Huygens. It was not until fifty years after the publication of Newton's *Principia* that D'Alembert showed that both views were correct and that momentum measures the force which a body can overcome with respect to time while kinetic energy measures the force that the body can overcome with respect to distance.

Professor Rettger then proceeded to develop the principles of work and energy and explained the methods used in presenting the principles to students. He stated that considerable attention is given to the solution of problems by the method of work and energy and that he finds this method of analysis leads, in many cases, to simpler solutions than are possible through the application of the free body method. As illustrations, he considered the problem of a body moving on a horizontal surface with an initial velocity and against a definite frictional resistance, and showed how the distance which the body would traverse before stopping was obtained. He then considered the more complex problem of a body moving down one inclined plane, traversing a horizontal plane, and finally moving up another inclined plane, and of determining the unknown resistance required to bring the body to rest at a designated point.

From problems involving translation he then proceeded to the application of the principle of work and energy to problems involving rotation, developing the various equations employed and illustrating how the topic is presented to a class.

After discussing problems of translation and of rotation, Professor Rettger dealt with the difficulties encountered by students in solving these problems because of the kinematical relations involved. The problem of a simple wheel or cylinder moving on a horizontal track was first considered, then a car wheel acted upon by journal friction, and finally an axle and wheel acted upon both by journal friction and by track friction. In every case typical problems were used to illustrate the principles involved. In the course of his remarks Professor Rettger stated that he believes that systems

of bodies should be used more frequently than they are in selecting problems to be assigned to classes.

Thursday, July 14. Afternoon Session

The afternoon meeting was devoted to seminar discussions of laboratory exercises as adjuncts to the teaching of mechanics. The conference was divided into three groups; Group 1, Professor J. E. Boyd, presiding, considering laboratory tests in connection with strength of materials; Group 2, Professor W. S. Franklin, presiding, laboratory tests in dynamics; and Group 3, Professor E. W. Rettger, presiding, laboratory tests in statics. In each of the groups designated members submitted sets of directions for performing laboratory exercises. These directions were presented in full and were then discussed by the entire group. The following topics were considered:

Group 1: Flexure test of a steel I-beam; tensile test of milled steel; compression tests of cast iron and wood; transverse test of wood; transverse test of cast iron T-bar; torsion test of steel.

Group 2: Spin inertia; determination of moment of inertia of a cylinder; determination of the value of the acceleration of gravity; determination of moment of inertia of various bodies.

Group 3 discussed various laboratory methods of illustrating principles of statics. No definite report outlines were presented but the various kinds of apparatus and methods of using them were discussed. In the opinion of the group it is difficult to devise apparatus to illustrate the principles of statics adequately, though something can be done in this direction.

Thursday, July 14. Evening Meeting

J. C. Parker: THE IMPORTANCE OF THE UNPRACTICAL.

Mr. Parker's address had as its theme the ultimate objectives of education. "First and foremost," he said, "I be-

lieve the objectives of all education must be the fitting of young people for life, not merely for earning a living, and least of all to become merely productive agents in industry. To fit our young men to earn a living without enabling them intelligently to spend what they earn and to enjoy life in the fullest and richest sense would be utterly futile."

Developing this idea, Mr. Parker felt that neither donors nor taxpayers have set up our great educational institutions for the direct benefit of employers, nor have the devoted men who give their lives in the teaching profession forsaken opportunities for greater material wealth merely to increase the earnings of stockholders. "For that matter," he said, "the same educational process would be indicated by intelligently endeavoring to satisfy both the real needs of industry and to promote the 'selfish' success of young engineers." He believes that education, inherently, cannot be made "practical," though there is insistent pressure to make courses of study serve immediately practical needs. Neither can the teacher reasonably be expected to be a good teacher and at the same time have contemporaneous and responsible experience of engineering practice, nor can the student possibly have the background of experience to enable him to appreciate in all its richness the implications of practical engineering. School life and its environment, he said, are essentially artificial.

The main requirement in all education, he felt, "is the development of intellectual vigor, mental power, character, and sympathetic perspective—meaning the capacity to relate intellectual vigor and character to the world as it is and to society at large. Intellectual vigor can only be developed through use, not through the accumulation of facts and processes. The strengthening of mental sinews should be the purpose of all college courses. Problems are given in order to develop capacity for inquiry and self-confidence, not so that students may stand and deliver back what has been poured into them."

Above all else in the "unpractical" things in education, Mr. Parker would place the development of character; of integrity, sportsmanship, a sense of team play, and of the

sanctity of duty without which no man is really fitted for life. In this connection he said, "Someone may say that a university is not a Sunday school and therefore need not concern itself with these things. Nevertheless, the problem of character development of young men is actual and insistent. I am not sure, either, that we need to sacrifice our subject matter in the process of developing character. I am not sure that if we conduct our classes as a serious business we cannot do about all that need be done in the development of character without ever doing one word of preaching, and I am very sure that the thing that most certainly will develop the kind of character that our profession and society as a whole really needs will not be any sort of mollycoddle process that would stultify the most exacting researcher or the most learned lecturer."

Mr. Parker spoke of the need for developing what he termed "sympathetic perspective" with the purpose of correlating engineering work with the needs of society. This, he believes, is exactly what is needed to disabuse the laity of the thought that the engineer is a sort of sublimated mechanic. "The engineering profession," he said, "will be advanced, the young graduate will make more definite progress, and the needs of society will be better served if we can turn out young men who know where their engineering work fits into the whole picture of life, and it should be to this end that we surround the undergraduate courses with the so-called cultural influences. In a mechanical age this seems to be tremendously important."

In concluding his remarks, Mr. Parker referred to the teaching of mechanics as a field in which wonderful opportunities exist for developing an appreciation of the way in which the engineering profession has evolved from the necessities of human existence and of the essential beauty of honest and sincere work. He would develop these ideas throughout the teaching of mechanics. Finally, the development of character, the recognition of the essential fundamentals, and an orientation to life, he believes, are the "unpractical" things which are basically essential in education.

Friday, July 15. Morning Session

E. W. Rettger: Couples.

In introducing the subject of couples, Professor Rettger first stated as his belief that students should be brought to a realization of the physical significance of the theories which they study. "I have come to the conclusion," Professor Rettger said, "that one of the greatest difficulties students have is to see that the principles of mechanics have physical significance. I feel sure in saying that most students are likely to fail to associate the things they study in class with their every-day experience. In my classes I try to show the physical significance of the theory and I find great improvement in the interest which students take in their work when that is done. It is not necessary to have complicated apparatus. A few sticks and some string may be all that is needed, for students have imagination. What is necessary, however, is to make them realize that we deal with real things. This may be done in many little ways. If the center of percussion is under consideration, for example, we may take a stick, tie a string to one end, and suspend it. A few trial blows will suffice to locate the center of percussion. Now give the dimensions of the stick and let the students locate the center of percussion by calculation. Let them follow up the simple demonstration by going through the calculations which the theory requires. This is an important matter. It may be argued that this is all very simple and elementary. It is. In fact, many a theorem in mechanics can be given an ocular demonstration in a few minutes, qualitative to be sure, but nevertheless sufficient to make the student realize that we are dealing with realities rather than with abstractions. As a rule, the concept of force is introduced very early in the course. Too often, however, the student fails to realize that the lines used in the derivation of the formulas concerning the resolution and composition of forces are more than mere lines. They often fail to realize that each line represents a push or a pull exerted on one body by another body. I em-

phasize the fact that we cannot conceive of a force except as the action of one body on another, but that for convenience we often represent this action as if it were an independent thing.'' Professor Rettger then gave a number of illustrations of methods of indicating to students the physical significance of the theories of mechanics.

He then took up the theory of couples, indicating how the above method of attack can be used to advantage in presenting this problem to classes, and illustrating his remarks by the use of a simple piece of apparatus. Two wooden disks are fastened together and have a common axis. The radius of one disk is larger than that of the other. The disks are placed on top of a smooth table and rest on balls so that they are free to move in any direction. Strings are wrapped around them. The strings then pass over pullies and weights are attached so that designated forces can be applied, tending to revolve the disks. A couple PP' is then applied and the two disks are rotated. If the principle of couples is correct, any couple of the same sense and moment should rotate the pair of disks in exactly the same way. A new couple P_1P_1', having $P_1 = 4P$, but having an arm one-fourth that of PP', is then applied. The couples PP' and P_1P_1' are then equivalent and the same rotation should be caused. Professor Rettger then performed the test indicated by the equations, showing that in both cases the bodies revolve about the same axis, thus showing the equivalence of the two couples, and continued by stating that such ocular demonstration will do much to indicate clearly to students the fact that relationships which can be proved mathematically are true when tested physically. He then discussed other simple tests on couples which could be performed by means of a yardstick, some weights, and a pair of spring balances, in each case demonstrating the proof of certain principles of couples which are taught to classes.

R. M. Stewart: SOME TEACHING PROBLEMS AFFECTING TEACHERS OF ENGINEERS.

Professor Stewart introduced his remarks by referring to the tendency, which has been so evident of late among those concerned with collegiate education, to scrutinize closely problems of teaching, and spoke of the Society's summer school as a striking illustration of this trend. Problems concerned with aims and purposes of instruction were, he said, the first to receive consideration. In this connection, three principal questions have been raised: (1) how may the teaching of professional and vocational subjects be improved; (2) what measures may teachers take toward self-improvement; and (3) the problem of the recognition of individual differences among students. As examples of the tendency of teachers to scrutinize the validity of their methods, he cited the Kiebler-Woody experiment in connection with laboratory instruction in physics.[1] As another example, he mentioned the discussion by F. J. Kelly in his recent publication, *The American Arts College*, of the weakness of the lecture method. Other examples might, he said, be given to indicate the widespread disposition among teachers to analyze and evaluate their work in the light of the ends to be served and of the new situations to be met.

One other question considered before the main points of the lectures were presented related to methods of recruiting teachers. Professor Stewart referred to the acute conditions which have resulted from the excess of demand over supply. In general throughout all branches of education, teachers at present have little advantage in schooling over their students. Methods of recruiting teachers were characterized as : first, the "falling-in" process, in which the college administrator simply looks over the field and selects the most promising material available without reference to specific preparation for teaching duties; second, the "semi-career" method, in which the college student has, more or less through chance,

[1] *Journal of Educational Research*, Vol. VII, January, 1923, pages 50 to 58, inc.

taken some work in educational method; and third, the "life-career" method, in which the student deliberately prepares himself to teach. The last method, in his opinion, has much to support it and should represent the normal process to a much greater extent than at present.

After these introductory remarks, Professor Stewart stated his main theme in the form of a question: "What are the main problems that we may well attack because they are pivotal in securing efficient instruction?" He then proceeded to analyze and discuss this general question by presenting six problems which must be solved if effective teaching methods are to be found.

1. The determination of purpose or aim. Before we can adopt means to reach our objectives in teaching we must determine what those objectives are and formulate them in concrete terms. A coordinate measure is the proper selection of students. It is essential that those admitted not only satisfy scholastic entrance requirements but, if they are to pursue a professional curriculum, that they have a professional purpose as well. Two aids to the accomplishment of this are available: (a) The selection of such secondary school graduates as have sufficient definiteness of purpose to profit by a professional program. This method involves the setting up of entrance standards which will bring about homogeneity in the group to be taught. If it is to be adopted, it should be worked out in cooperation with secondary schools, for it does not greatly aid merely to criticize the secondary school product. (*b*) The colleges themselves may assume a part of the responsibility of sifting and orienting students by preparing them after admission for the programs of study they are to undertake. It seems inevitable that the latter method must be used for a while since the public high schools will necessarily continue, to a considerable extent, to turn over to the colleges a heterogeneous group.

Professor Stewart believes that before we can sift and orient students and instill purpose into them, we must ourselves know what we want. Concretely, to what extent, on the one

hand, do we wish to develop mental vision, or, on the other hand, to train students with specific skills such as the ability to make computations? Three objectives or aims of teaching should be recognized: (*a*) the development of *skills;* (*b*) the imparting of *knowledge;* and (*c*) the development of attitude or *appreciation* toward the subject taught. The plans of teaching procedure to be adopted must be developed in accordance with the relative weight to be given these three objectives. The selection of the subject matter itself must be in accordance with that aim. Furthermore, the ends sought should be fixed in accordance with the difficulties to be overcome. In this connection the age of the student, his mental maturity, and his background of experience, are factors involved. This thought, he said, leads to consideration of what kinds and levels of appeal may be used with students. These may be stated as follows: (1) the appeal to the free expression of natural tendencies; (2) the appeal to the accepted restraints such as those which the social unit imposes; (3) the appeal of utility; and (4) the appeal to intellection, which we accept as the highest level of control over activity.

2. The second problem of teaching has to do with the analysis of activities associated with the field of application of the unit of instruction under consideration. Such analysis is basal to the definition of aims and to the clarification of purpose; it is only through analysis that we can arrive at the proper means and methods to be applied in the learning process. In analyzing any teaching problem, the process must be broken down into its component factors. The extent to which such an analysis is to be carried must be determined in advance. It cannot be a hit-or-miss matter. To be valid, the analysis must be based upon real problems of actual situations and not upon purely fictitious ones. The aim of the good teacher will be so to conduct his analysis as to uncover what is needed for the solution of his immediate problem.

3. In the process of analysis certain pivotal points will emerge as the major questions of the lesson. The third problem is the determination of these points. The solution of the

problem of presenting any lesson to a class will depend upon the answers to those key questions which represent the larger steps in the "unit" and which make possible the arrangement of the mass of data involved in any given problem into an intelligible and meaningful whole. Naturally, for students dealing with a subject for the first time, any one lesson should involve relatively few such key questions.

4. The fourth question relates to the order of the pivotal questions or points in the series. For efficient learning, it is all important that the order be as nearly correct as possible. The first step in the solution of any problem is orientation, that is, the bringing of the student's relevant experience to bear upon it. This step is essentially the approach to the problem and in addition to bringing the student's experience to bear, it should open up avenues for the attack upon the problem itself.

Three practical questions confront the teacher in setting up a superior teaching plan and in devising an orderly arrangement of points in any teaching unit: (*a*) The evaluation of the student's capacity to do that which is required, and the determination of the experience which he can bring to bear upon it. If his experience is abundant, the major emphasis may be upon the use of that experience. If not, the emphasis may be upon the gaining of new experience. (*b*) The control and mutual adjustment of the use of experience and the gaining of new experience to the end that the process of learning may be uniformly accelerated. (*c*) The determination of whether the arrangement should be based on a logical or on a psychological method of approach. By psychological is meant the extent to which the teacher considers the nature and experience of the student. Since it is the purpose of the teacher to reach his goal by the shortest possible route, he cannot disregard the principle of self-activity, and he must, therefore, to a large extent, use the psychological method of approach to the solution of his problems.

5. The fifth problem involves the selection of teaching methods. All of the preceding steps, namely, (1) the determina-

tion of purpose, (2) the analysis of activities as the basis of determining what to teach, (3) the selection of the logical points of development in the lesson, and (4) the scientific arrangement of those points, imply the selection of appropriate methods of instruction. Almost invariably a thorough analysis of these points will be found to indicate the most appropriate method to be used. If controlled discussion serves the purpose better than the lecture; if the demonstration laboratory is as valuable as the individual laboratory test; if the practicum provides better for participation of the student than the textbook discussion; then these methods must be considered in the selection of the most appropriate means of presenting the subject.

6. The teacher must choose a means of testing the results of his teaching. The instrument of testing must be appropriate to the thing measured and must be set up in terms of the results which are expected as the outcome of the teaching. Measurement thus becomes not only a means of learning but is also a measurement of the teaching as a whole. To think of an examination as a method of teaching will give it a more correct place in the whole teaching process.

In conclusion, Professor Stewart stated that he had presented these six points with the hope that they might be applied to problems connected with the teaching of engineering.

Professor Stewart's lecture was followed by discussion. In answering a question which related to lags in the learning process, which might be characterized as "plateaus in the gradient of learning," Professor Stewart stated that they might be due to a number of causes. If the lags indicate "assimilation" they are not objectionable. In this connection, he expressed the belief that concentrated instruction seems not to provide sufficient periods for the process of assimilation. If, on the other hand, plateaus are due to defects in teaching method, means should be sought to remove them. This is education's opportunity in method. In answer to a question, Professor Stewart stated his belief that students are likely to become discouraged in their plateau experiences;

hence the tendency to a high rate of mortality as we proceed upward in any given course of instruction toward the more involved levels.

Another point in the discussion related to the relative emphasis to be given to the development of skill, acquirement of knowledge, and development of "appreciation" in teaching work. It was felt that all three ends should be served in a properly balanced engineering curriculum, the needs of the students determining the relative weights to be given to the three aims.

Friday, July 15. Afternoon Session

At the beginning of the afternoon meeting Associate Director Hammond gave an informal account of the work in progress at the Wisconsin session of the summer school, which he had just visited, paying particular attention to the projects undertaken by committees of members and to the lectures and discussions led by Professor Curtis Merriman on general education method and upon teaching methods in mechanics.

The conference then divided into three groups for discussion of the topic *Classroom Methods in Teaching Mechanics.*

Seminar Group 1. **J. E. Boyd, Leader.**

The *method of presenting an A-frame problem* to a class was given by Professor F. N. Weaver. The problem was selected as an example of classroom methods employed in teaching the subject matter of statics and was presented as a basis of discussion and criticism. Professor Weaver endeavored as closely as possible, lacking an actual class of students, to indicate the methods he employs and the means he uses of overcoming students' difficulties. It was assumed that the class had studied the simple relationships in statics and that the A-frame problem had been assigned for study but not for numerical solution. He outlined his methods as involving the isolation of each member of the frame and the calculation of the horizontal and vertical components of all of the forces acting upon it. The teaching problem involved

was attacked by first selecting the point or points at which the analysis should be begun, this in turn involving first the determination of the reactions and then the selection of the appropriate order for the consideration of the individual members. Various errors into which students fall were pointed out and methods of having the students themselves reason out correct methods of analysis were indicated. Attention was given to the determination of certain of the numerical results by inspection and mental calculation as compared with written computations. Appropriate methods of checking the analysis and the accuracy of the results by graphical means were presented.

Professor Weaver's method was essentially that of discussion led by the instructor with informal quizzing of the class as the analysis proceeds, the instructor doing the work at the board but calling upon different students in turn to take up successive steps in the solution.

The presentation was followed by discussion from which it appeared that the method of class discussion led by the instructor, with informal quizzing of the class, was used by a number of those present. It was felt that the method is appropriate for much of the work in mechanics.

Following Professor Weaver's presentation, Mr. F. B. Schell, in a similar way gave the methods he employs in teaching the subject *horizontal shear in beams.* Mr. Schell first considered the fundamental nature of horizontal shear and the conditions under which it arises in significant magnitude. He then demonstrated the derivation of the basic equations for the intensity of horizontal shear, and developed the conditions under which it is maximum. In the course of the presentation he pointed out how various difficulties which students encounter may be dealt with and their confusion on certain points removed.

Seminar Group 2. **W. S. Franklin, Leader.**

Methods of conducting classes in mechanics and hydraulics at the State University of Iowa was the topic presented by

Professor F. E. Holmes. Professor Holmes explained that the class in mechanics meets twice each week for periods of three hours during the entire junior year and that all of the work of the course is done during the class hours. Each period is divided between study, computation, recitation, and, at intervals, written quizzes and examinations. Each student is provided with a desk of the sort used in business offices and with a drawing table. Except during recitations, when the class is called together at the front of the room, the students work at their desks. The instructors pass around among the students, giving assistance and advice when needed or asked for. Since the classes are small, the students get a great deal of individual attention. Mastery of subject matter, neatness, and accuracy are stressed and the effort is to have the work conform to the standards of actual engineering practice. Sections of the class are segregated according to ability. Requirements of the course are planned for the average section. Many written quizzes are given and any part of any period may be taken for an examination.

Experience has shown that students in the best sections will not do extra work for the same credit, and the work of the different sections has, therefore, been differentiated by permitting the better students to complete the work in a shorter time.

No laboratory apparatus is used in the teaching of mechanics. The final grade is based upon daily work, quizzes, and final examination. Application, accuracy, neatness and promptness are also taken into account.

During the discussion of Professor Holmes' paper Mr. Converse explained that at the California Institute of Technology honor sections are formed and the students are allowed to attend a special class, which meets only one hour per week, for discussion of theory. The honor section is selected on the basis of the previous year's average grade. The final grade of the student is based entirely upon the final examination.

Seminar Group 3. E. W. Rettger, Leader.

The first portion of the hour was devoted to an explanation by Professor I. H. Prageman of the methods employed in the engineering problems course given during the sophomore year to engineering students at the State University of Iowa. The work is conducted by means of the three-hour supervised study period system, as indicated above in the remarks of Professor Holmes, and occupies two three-hour periods per week for one semester. The purposes of the course are (*a*) to correlate the work in elementary mechanics and physics with actual engineering problems; (*b*) to inculcate orderly methods of computation and to illustrate some of the common methods of calculation used in engineering offices; (*c*) to develop the habit of engineering judgment and to insist upon accuracy in all of the work undertaken. Professor Prageman touched upon the matter of sectioning on the basis of ability and said that the practice was being abandoned because of changes in the curriculum and because the results had been disappointing.

Professor J. S. Lambie presented as a basis for criticism of methods often employed in courses in mechanics, the problem known as Huygen's paradox. The "orthodox" solution, Professor Lambie explained, involves the setting up of four equations which are then solved algebraically. He contended that the solution was almost exclusively a matter of algebraic manipulation which does not call upon the student to analyze the mechanical principles involved and that it led to a blind substitution in the formulas. This was criticized as not conducive to clear thinking. As an alternative he presented a second method of solution in which each element of the problem is discussed from a basic mechanical standpoint. Sharp discussion followed Professor Lambie's demonstration, most of those attending feeling that the ordinary method of solution is preferable.

Friday, July 15. Evening Meeting

Charles F. Scott: SOME OPPORTUNITIES FOR TEACHERS OF MECHANICS.

Before touching upon his main topic, Professor Scott reviewed the activities of the Society in its recent investigations and spoke of the steps leading up to the inauguration of the summer school. He stressed the growing opportunities and responsibilities of engineers and the new demands upon engineering education incident to our rapidly evolving civilization. He then pointed out the relationship between the teachers and the teaching of mechanics and these conditions and said in part:

"The teacher of mechanics is fortunate in his subject. Mechanics deals with common experiences of life, with force and motion, inertia, acceleration and work. These are facts to which we have learned to adjust ourselves. In the study of mechanics we begin with observation in a field already familiar. We observe from a new point of view that with which we are already acquainted. The common experiences of life are looked at in a new way. The student finds out more about things he already knows; he proceeds from the known to the unknown. He makes measurements. What he has already known qualitatively he determines quantitatively.

"Now, this ability to see things about us with a new vision and to measure and reason about them is fundamental to the scientific man and the engineer. The methods as well as the facts of mechanics are the basis of engineering.

"The student of mechanics by observation and measurement finds that the phenomena with which he is familiar follow definite laws. He gets an insight into the meaning of the laws of nature. He finds that they are simple laws. He sees that mathematics is useful in expressing them and applying them to new conditions. He learns to visualize; he finds that laws and formulae are not abstractions but are expressions of physical relations. He learns to picture in his mind

the realities which the equation represents. He gains inestimable training in definite, accurate, 'non-sloppy' thinking and in definite, accurate, 'non-sloppy' expression.

"Now all this is an ideal training not only for the engineer, but for the intelligent man in whatever field his life work may fall.

"A teacher of mechanics can do more than teach mechanics mechanically. I have had two teachers, S. W. Robinson, reticent and uncertain in speech, at Ohio State, and Fabian Franklin, effervescent and excitable, at Johns Hopkins. They gave life, interest, enthusiasm. Their keen interest in the student and their enthusiasm in making problems simple and clear made their classes a delight and an inspiration.

"Those of you who have read the biography of Benjamin G. Lamme will recall his tribute to Professor Robinson. In a recent discussion the question was raised whether the superior student should be expected to do more than the average student. On the principle that education is a matter of exactions and requirements it was urged as unjust to expect a student to do more than is required for his diploma. Lamme is an example of the student who did not recognize such limits. His superdiligence and the methods which he learned from his teacher of mechanics gave him an outstanding position among the pioneer scientific designers of electrical machinery.

"A report of the Board presented to the Society last month advocated the unified method in engineering education by which humanistic, scientific, and technological studies are incorporated in a single curriculum. We plan to make the non-technical, the humanistic, the 'cultural,' if you choose, not something apart from the technical and professional, to be gotten during preliminary years in a separate school, but something which is to be coincident and coordinated with the technical. The engineer should appreciate the significance of his own work in relation to life in general. Culture is not a particular subject or a course; it is rather an attitude. It is well that the humanistic subjects be made simultaneous

with the technical and adjusted to the engineering student; but this is not enough. Engineering education must seek its enrichment from within. It is the teacher who makes a course broad or narrow. Any teacher may make his subject the doorway which admits his students to his own life and interests. In our own experience we can recall the teacher—of geology or history or machinery—who gave us a new vision of the larger significance of science or history or industry and their relations to life.

"The teacher of mechanics may make it the dry, abstract, mathematical grind it is often thought to be, or he may make it the cornerstone in scientific and engineering training in subject matter and in method, unifying in the student's mind the sciences and the branches of engineering of which it is a part and pointing out the wondrous part that applied mechanics is playing in present engineering achievement; and he may impart to the student the interests, the enthusiasms, the vision and the ideals of his own life."

Following Professor Scott's address, a recital on the cello and piano was given by Professor Vladimir Karapetoff, of the Cornell faculty, in the great room of Willard Straight Hall. The recital was attended by all of the members of the conference, as well as by a number of guests and visitors.

Saturday, July 16. Morning Session

Stephan Timoshenko: Problems of Elasticity in Mechanical Design.

The above topic was discussed by Dr. Timoshenko as a portion of the program devoted to advanced phases of mechanics.

The speaker pointed out that, because of increase of dimensions and of the speed of rotating parts, stresses in machine parts are increasing rapidly, and that because of the variations in cross-sections, localized stresses are produced which are of great importance. In many cases such stresses cannot be analyzed by the ordinary formulas of mechanics. Many of the complicated practical problems can be solved only on the

basis of approximate or experimental methods. This, the speaker said, has resulted in the development of the study of mechanics along lines quite different from those considered in the ordinary undergraduate courses. It was his purpose to consider some of these recent developments.

Analytical Method.—As an illustration of recent developments in analytical methods he considered the local stress set up at a circular hole in a plate under simple tension in one direction, then under simple tension in one direction combined with compression in a perpendicular direction. Reference was also made to thin tubes submitted to twist, and it was shown that the stress near holes in such tubes was much greater than the stress in a tube without a hole. In the case of narrow elliptical holes extending in a direction perpendicular to simple tension it was pointed out that very high stress concentrations would be caused, while stress concentrations would be smaller if the hole is parallel to the tension.

Photoelastic Method.—The speaker then observed that more complicated cases can be dealt with by analytical methods only with great difficulty and that the photoelastic method has been of assistance in such cases. The method involves the use of celluloid or bakelite models. Since the models are in the form of plates they represent stress distributions in two dimensions only. Dr. Timoshenko explained that the measurement of stress in these models is based on the fact that such isotropic materials as celluloid and bakelite become double refractory under stress action and if a beam of polarized light crosses a transparent model under stress, a colored picture is obtained from which stress distribution may be found. After passing through the plate the beam of polarized light passes through an analyzer, and the effect on the screen will be a colored spot or area, the shape or position of which will depend upon the distribution of the maximum shearing stresses in the model, this in turn being the index which is used in the analysis. The use of the method with irregular sections such as gear teeth, fillets, dovetails, etc., was shown.

The Method of Lueder's Lines.—This method involves the use of metals having a pronounced yield point and a polished or painted surface so that when subjected to tension the sliding of metal along the planes of maximum shearing stress appears when the load approaches the yield point. Under test, the stress at which the lines appear can be measured and used in determining factors of stress concentration in such cases as plates with circular holes, fillets, etc. One of the advantages of this method is that it can be used in three dimensional problems.

Fatigue Test Method.—Dr. Timoshenko pointed out that the analytical and the photoelastic methods determine stress concentrations only within the elastic limit. He spoke at some length of the behavior of ductile and brittle metals under stress beyond the elastic limit; the effect of preventing lateral contraction; and the effect of stress concentration where a reversal of stress takes place. He referred to fatigue tests conducted to procure data indicating the strength of different metals under a reversal of stress at points of high local stress concentration and considered the results of such tests for various forms of specimens and kinds of metal in considerable detail.

In conclusion, Dr. Timoshenko considered stress concentration at the fillets of shafts of variable cross section. Assuming a cylindrical shaft of uniform cross section submitted to twist, and considering the shaft as being divided into elementary tubes so that each tube takes an equal part of the torque moment, he pointed out that, due to the fact that the shearing stress, the circumference of elementary tubes, and the arm of the torque moment acting on elementary tubes are all proportional to radii of the tubes, the thickness of the tubes should be inversely proportional to cube of their radii in order to have the same torque moment. A longitudinal section of the cylindrical shaft showing the elemental tubes parallel to the axis, and another system of lines at right angles representing equidistant cross sections of the shaft, were then drawn, and the lines parallel to the axis designated

equimomental lines, while those perpendicular thereto were called equiangular lines because the angle of twist between each two consecutive lines of this system would be the same along the axis of the shaft. He then illustrated the use of these equimomental and equiangular lines in calculating shearing stresses in torsion in circular shafts of constant or of variable cross section.

Saturday, July 16. Afternoon

The afternoon was spent by members of the conference on a trip to Taughannock Falls and Park. A picnic supper was prepared and served on the beach.

Monday, July 18. Morning Session

W. S. Franklin: Dynamics of Rotation.

In preparation for a lecture on the gyroscope, to be given on July 26, Professor Franklin considered the dynamics of rotation, paying particular attention to steady motion, to steady-state motion of the gyroscope, to "gyro-elasticity" and to the gyro-compass. The material of Professor Franklin's paper is of such character that an abstract would be unsatisfactory and would not convey a clear picture to the reader. Limitation of space prevents publication of Professor Franklin's excellent paper in full.

J. E. Boyd: Experimental Verification of Column Formulas.

This session of the conference was devoted to a laboratory demonstration of the experimental verification of Euler's column formula. The test was performed with a 400,000 Riehle testing machine. The column tested was a round steel bar, 1¼" in diameter and 60" long, equipped with Ames dials for the measurement of lateral deflections of the test piece. Loads were applied to the column under two conditions: first with an eccentricity of about 0.0002 inch, and second with an eccentricity of about 0.01 inch. In each case the "critical"

load was determined and was found to check very closely with the calculated critical load.

Monday, July 18. Afternoon Session

The afternoon sessions were devoted to discussion of the experimental demonstration of the morning. Professor Boyd developed the Euler column formula, computed deflections of the test specimen for various loadings and compared the computed deflections and eccentricities with the observed values. Close agreement between theory and test was obtained. Professor Boyd's presentation was followed by discussion.

Tuesday, July 19. Morning Session

E. W. Rettger: SIMPLE BEAMS.

Professor Rettger's presentation was one of several devoted to mechanics of materials.

In opening his remarks, Professor Rettger referred to the fact that many students pursuing more advanced courses in civil engineering, particularly framed structures, have trouble in problems relating to beams, and especially to simple beams. The difficulties appear to lie in the determination of bending moments and shears and the location of sections of maximum moment and shear, and to the application of the theory of flexure.

He proposed, therefore, to discuss the teaching of simple beams from two standpoints: first, an analysis of the theories of simple beams and the flexure formula, and second a discussion of the difficulties which students encounter and ways of overcoming them. Professor Rettger first presented the elements of the flexure formula, demonstrating his method of treatment and indicating both the scope and the limitations of the common formulas. He pointed to a number of conditions which are commonly overlooked in the application of the flexure formula and stated that after the student has acquired a working knowledge of the simple formulas he should be made to appreciate some of the conditions under which they

cannot be applied with safety. He then took up the determination of sections of maximum moment and maximum shear, indicating how such sections are located, and discussing the conventions as to signs and his methods of drilling classes so that signs can be correctly affixed. Concluding the demonstration of the simple beam formulas, Professor Rettger illustrated the solution of a typical problem as it would be given in a class of undergraduates.

Professor Rettger then discussed various aspects of his classroom and problem work methods, pointing out the chief difficulties encountered and ways in which they may be overcome. In particular he described a simple experiment designed to demonstrate the relation between external forces and the stresses at a given section of a beam which, he said, he had found helpful in bringing students to a correct understanding of the theory of flexure.

J. E. Boyd: STATICS OF CONNECTED BODIES.

During this period, Professor Boyd considered graphical methods of solving problems in statics. As in previous sessions, he advocated the use of angles other than 30, 45, and 60 degrees, believing that they give the student better training in the solution of problems likely to be encountered in practice. He also advocated the use of Bow's method of lettering space diagrams, where each area bounded by members is designated by a letter instead of using letters at the joints.

Professor Boyd then solved a problem on a statically determinate truss, indicating the methods of obtaining the reactions and the stresses in the several members. In the solution, Professor Boyd first employed an analytic method and then showed how graphical means may be used to check the analysis.

A more simple suspension frame of two connected members of unequal lengths supported at different levels was then discussed. The method of moments was used to determine the reactions and the customary method of resolutions to determine stresses in the members.

Throughout his remarks Professor Boyd referred to the graphical method more as an auxiliary method to be used at times and as a good means of checking results than as a primary tool in the solution of problems on the statics of connected bodies. He especially favored Bow's method of designating members and referred to the ease with which the character of the stresses is determined when that method is used.

Monday, July 18. Evening Meeting

W. E. Wickenden: ENGINEERING EDUCATION AND THE SOCIAL ORDER.

Dr. Wickenden developed as his theme the function which engineers serve in the social order of today. He emphasized the need, on the one hand, of the wider adoption in other vocations and fields of activity of the professional ideals and standards of engineering and its method of approach to the solution of problems, and, on the other hand, the need in engineering and in engineering education for the development and amplification of cultural standards. The principal points brought out in his address are summarized in the following paragraphs.

There is need of a philosophy as well as a technique of engineering education. Others judge our work less by its excellence as a technical discipline than by the attitude toward human interests that we instill into our students. The modern social fabric is based on an interchange of specialized services and we dare not abandon the training of technologists for the alluring, and perhaps illusory, work of training leaders. Men must prove efficient on the functional plane before they are called up to leadership. To help young engineers to make that step we must make them effective as self-educators.

The engineer stands for a type or function much needed in wider reaches of society. His profession is not esoteric in tradition, and he is pioneering in introducing professional ideals and standards into the complex team work of industry. He bridges the gap between research and production with a

scientific technique for the control of nature, a technique of human effort and a technique for appraising social and economic values. Similar blending of technique and ideals is needed in realms of commerce, finance, politics, social amelioration and religion.

Engineers need to defend and amplify the cultural contributions of their calling. The traditional "liberal arts" were aristocratic in spirit, and implied by contrast the "vulgar arts" of trade, industry and labor. Such an ideal might serve an era of slave labor which reserved learning and light for a few and offered only uninspired toil to the many. We do well to challenge the idea that wisdom, sweetness and light are to be sought chiefly in the lore of the ancients. Modern technology, by multiplying production, is opening an era in which a fair measure of comfort and leisure are possible for all, with a share in mental and spiritual privilege beyond what the ancients imagined for their gods. Scientists and engineers are now called on to measure aright the social forces they release, and to claim a larger share in directing them to beneficial ends.

Tuesday, July 19. Afternoon Session

Professor K. D. Wood presented for consideration at a general meeting the application of the *True-False* and *Yes-No* types of examinations in courses in mechanics. Two sets of examination papers were distributed. The first deals chiefly with fundamental conceptions and definitions in mechanics and contains thirty-one questions, each of which is answered by means of a check mark to indicate whether the statement is true or false. Five typical questions of this examination are listed below to indicate its general scope:

1. Vector quantities have direction as well as magnitude.
2. The magnitude of the normal component of the acceleration of a point is equal to the square of its speed divided by the radius of curvature of the path at the specified position of the point.
3. When a force, or system of forces which does not have zero resultant, acts upon a particle, the velocity of the particle is constant.

4. The area under a v–t graph between two times t_1 and t_2 represents the distance covered in that time interval, if v is used to denote the speed of the particle.

5. If a ship moves so that the resistance to its motion varies as the cube of its speed, and if the power is turned off, it will theoretically come to rest within a definite time.

The second examination deals with specific problems in mechanics and is answered by the student by placing the letter "Y" in front of those statements which he finds to be correct, and the letter "N" in front of those which he finds to be incorrect. The examination contains sixty-five questions, four of which are given below to indicate its nature:

1. An automobile weighs 2000 pounds. Its center of gravity is midway between the front and rear wheels. The machine has four-wheel brakes but drives from the rear wheels only.

(*a*) If the machine moves at constant speed up a 10 per cent grade, is the normal pressure on the front wheels less than the normal pressure on the rear wheels?

(*b*) If the machine moves at constant speed on level ground, will the total normal pressure on the two front wheels be 1000 pounds?

(*c*) If the machine is running on level ground and the brakes are applied so that all four wheels skid, is the normal pressure on the front wheels greater than the normal pressure on the rear wheels?

2. A transformer is cylindrical in form, 6 ft. in diameter, and 12 ft. high. Its c.g. is at its geometrical center. It is transported on a flat car and is prevented from slipping by cleats. Assuming $g = 32$ ft./sec.^{2}.

(*a*) If the car decelerates at 10 ft./sec.^{2}, will the transformer remain standing?

(*b*) Will the car be able to go safely around a curve (unbanked) of 300 ft. radius at a speed of 90 ft./sec.?

3. A slender rod (wt. $= 32.2$ lb.) is pivoted as shown to a bracket at point (o), which rotates with the shaft at a uniform speed of 6 rad./sec.

(*a*) Is the resultant force acting on the rod equal to 36 lb.?

(*b*) Does the resultant force acting on the rod act at the center of gravity of the rod?

(*c*) Are the horizontal components of the two bearing reactions equal?

(*d*) Will the cord break?

(*e*) Are the products of inertia of the rod with respect to axes through the center of gravity of the rod equal to zero?

(*f*) Are the external forces acting on this apparatus in equilibrium?

4. The flywheel of a punch press increases its speed from 80 to 120 r.p.m. during the time that the press is not punching.

(*a*) Is the coefficient of speed fluctuation of the flywheel 40 per cent?

(*b*) Would a 300 lb. flywheel be sufficient to keep the speed variation within these limits?

Professor Wood stated that ninety per cent of his class completed the first examination in from nine to fifteen minutes, and that fifty-five per cent completed the second examination in from forty to sixty minutes.

In discussing the use of the true-false type of question in examinations in mechanics, Professor Wood pointed out that it is possible to cover a great deal more ground in the examinations, that objective grading is favored, and that ratings are likely to be much more reliable. He stated that the method did not, of course, test the student's ability to make complete numerical solutions. He felt, however, that its use is quite stimulating. At Cornell, he said, this type of examination does not supplant the more common type of final examination. He then proceeded to discuss the results of such examinations, including such points as the length of time needed by the students to answer the questions and the percentage making various scores on each of the two papers presented.

Spirited discussion followed Professor Wood's remarks, some favoring the use of the type of examination described, others disapproving. While no count was taken, the majority felt that this type of examination should not entirely supplant the older form in which the student is required to make complete solutions. There was considerable discussion of the whole topic of the use of objective type of examinations and also of the use of so-called intelligence tests as a requirement for admission.

The conference divided into three groups under the leadership of Professors Boyd, Franklin, and Rettger, respectively, for the discussion of the topic, *Preparation of Examinations in Mechanics*. Members of the groups presented typical sets of examination questions employed by them, which were then discussed. Most of the examinations were of the usual form requiring the student to solve problems or write definitions. A few were of the "objective" type. The entire set of examinations is on file in the bound volume of Proceedings in the Society's office, and would repay careful study.

Wednesday, July 20. Morning Session

C. M. Allen: Hydromechanics.

The two morning sessions were addressed by Professor Allen, who spoke on the topic *Hydromechanics* from the standpoint of methods employed at Worcester Polytechnic Institute.

The course at Worcester calls for one lecture and two recitation periods per week for one-half year. Classes are divided into sections of from twenty to thirty students each. In assigning the work of the course, the paragraphs of the textbook are designated and marked by the students as of first, second or third importance. The recitation periods are usually conducted by devoting the first ten or fifteen minutes to the answering of questions raised by students. During the next ten or fifteen minutes the instructor questions the class and during the latter part of the hour, a problem is assigned which is solved by all members of the class at their seats. This problem is explained in the next period.

In discussing the matter of grades, Professor Allen felt that the first month's grades in a subject mean little and that those of later months are more accurately indicative of performance.

The classroom work is paralleled by a laboratory course of eight weeks' duration which includes seven experiments, each of which requires in all about seven hours of time.

Professor Allen then described the first lecture of the course in hydraulics which is intended to arouse the students' interest and to provide orientation to the subject. To do this, he reminds the students of the various properties of water in a lecture largely of a popular character, through which are interspersed remarks, comments or stories of a more or less striking character. Properties and characteristics of water are considered and illustrated under the headings: chemical composition; compressibility; surface tension; solubility of gases, minerals, etc.; density; and the like. During the first lecture, problems are suggested or assigned which are de-

signed to arouse the student's interest and to make him think about the subject. The following is an illustration: "A boat is propelled by a jet issuing from a pump placed on board. How does the efficiency of the pump in moving the boat vary as the water is taken from the front, the side, or the stern of the boat, or from a supply of water on board?"

Considering the course in hydraulics itself, Professor Allen stated that the purpose was to familiarize the students primarily with the principles of hydraulics, rather than its applications, though both theoretical and practical problems are given. Memorizing of formulas is not required. The use of the slide rule in solving problems is permitted only when they can not be solved by mental arithmetic.

After an intermission, a series of slides was shown indicating the layout and design of the hydraulic laboratory at Worcester, and also certain of the parts of the apparatus and experiments in progress by students at the laboratory.

Thursday, July 21. Morning Session

E. W. Rettger: THE ANALYSIS OF FIXED AND CONTINUOUS BEAMS.

Professor Rettger's lecture was in continuation of his remarks of July 19, on the subject of beams and included consideration of continuous and fixed beams and the various methods of analysis applied to them, namely:

Elastic curve method,
Slope-deflection method,
Moment area method,
Theorem of three moments,
Method of equating deflections,
Method of least work,
Method of unit load.

Illustrations of the applications of these methods were given by the analysis of particular cases. Comparative ease of analysis was discussed. Preference was expressed for the

moment-area method for general use because of its wide applicability and ease of handling. In Professor Rettger's opinion little attention should be given to the last two methods named above in courses in mechanics, their application coming chiefly in courses in framed structures. In each of the demonstrations of the several methods, attention was directed to methods of presenting them to classes and consideration given to difficulties commonly encountered by students.

During the course of his remarks, Professor Rettger called for expressions from members of the group as to their methods of dealing with problems on fixed and continuous beams. The moment-area method was generally favored.

W. S. Franklin: EXAMPLES OF MECHANICAL WAVE MOTION.

Professor Franklin's lecture was the first of two devoted to the consideration of mechanical wave motion. Its purpose was to indicate one line of advanced study in mechanics which may be explored by the teacher with profit. Consideration was given to the mechanics of compression waves in water pipes with particular attention to the differential equation of motion of water in a distensible pipe, pure waves in a distensible pipe filled with a compressible fluid, and to two specific problems illustrating the principles involved. Professor Franklin's treatment of the subject was mathematical and was given largely as preparation for the second lecture on mechanical wave motion to be given on July 22.

Thursday, July 21. Afternoon Session

The group met as a unit and the entire afternoon was devoted to general discussion of methods of teaching. Papers were read and demonstrations given by Professors N. C. Riggs and P. G. Laurson. An abstract of Professor Rigg's paper is given below; that of Professor Laurson is printed in full in Part IV. The papers were followed by discussion.

Professor Riggs spoke first of ways of improving teaching methods. Among other points, he stressed the importance of maintaining an attitude of friendliness and sympathetic un-

derstanding toward the student; of exercising care that not too much is assigned so that the student is unable to give some thought to other things than his work or, worse, led to copy from others in order to meet requirements which he considers excessive; and of insisting upon reasonable neatness, legibility, and understandable arrangement of work.

To be successful, he feels that the teacher must have a keen interest in the subject matter of his course. He believes that the work of any course should be so proportioned that the student's attention and interest are continually challenged.

Speaking of his own classroom methods, he said that at the beginning of a period, he usually asks for questions on the previous day's work, and always receives them. He then clears up difficulties, straightening the students out on any ambiguity if the fault is with the text, or, by further questioning, bringing out the principles involved if the difficulty rests with the student. Following the questioning, there is blackboard or written quiz work. When a few of the faster students complete the problem all are sent to their seats and the problem is explained either by the student or by the instructor, the latter method seeming to give the better results. If a difficult topic is assigned for the next day, a part of the hour is devoted to explanation with the idea of forestalling difficulties. Professor Riggs emphasized the danger of going over a new topic so hastily that many students are unable to follow the explanation. This, he said, is often worse than no explanation at all, and care should be exercised to see that the students understand clearly each step of the analysis.

Following this presentation, Professor Riggs selected as a particular problem the solution of the catenary as an illustration of his method of presenting a given subject to a class.

Friday, July 22. Morning Session

W. S. Franklin: Examples of Mechanical Wave Motion.

This was the second of two papers by Professor Franklin on this subject. In it he considered wave motions set up in metal bars when struck at one end. Theories of wave motion

having been developed in the previous paper, illustrative problems were considered. Professor Franklin's purpose was to show a number of applications of the principles of mechanical wave motion to practical problems of importance. Space does not permit of the printing of Professor Franklin's remarks in full and a summary does not give a reasonably accurate idea of the content of the lecture.

The program committee announced a digression from the announced topic for this period. In response to requests from several members of the conference, the meeting was devoted to discussion of the topic *Self-Improvement of the Teacher*. Professors Rettger, Laurson, Riggs, and Bullard were selected by the committee to express their views on the subject.

Professor Rettger urged that every teacher should do something to keep himself alive; that he should always be doing enough work in his courses to keep from becoming stale. Further, he stated that every teacher should engage in some sort of research work. To illustrate his point, Professor Rettger mentioned that at one time his classes had seemed to lack interest in work on columns. Feeling that this might be due to his own lack of interest in the subject or failure to keep progressing in it, he studied the treatment of the subject by several authors, did considerable reading, studied the results of tests in a number of publications; in short, made a more detailed study of columns than he had ever before made. As a result, he not only unearthed much information concerning columns that was new to him, but afterward observed that the interest of classes in the subject was measurably increased.

Discussing the qualities which are most important in successful teaching, Professor Rettger said in part, "One thing is certain, however: A thorough knowledge of one's subject is absolutely indispensable. There is method in a subject. Understand a subject thoroughly and much of the method of teaching it suggests itself. If, in addition, the teacher has

common educational horse sense, he may become a good teacher without ever having made a study of formal pedagogy. In fact, the best and most inspiring teachers I ever had could not qualify as authorities on pedagogy as pedagogy was taught at that time. They had educational horse sense and they were alive. Just to be in their presence was stimulating."

Professor Rettger stressed the necessity of continually progressing in one's work. So long as the younger teacher is working up his subject, selecting illustrative problems, developing new methods of treatment, etc., he is alive. "Later, however, when these things have been worked up, most of us are apt to rest on our oars. It is then that some other stimulus is required to make us go forward." Such stimulus, in Professor Rettger's opinion, may be found in research. In research work, he advocated the selection of one topic at a time and the making of an intensive and extensive study of it. Collateral reading, he stated, is also a great help to continued advancement.

Following Professor Rettger's remarks, the discussion was continued by Professor P. G. Laurson. Among other points he mentioned the advisability of maintaining contact with actual engineering work through professional practice and through attendance at meetings of professional engineering societies. One of the best reasons, he said, for keeping up interest in engineering is the valuable contacts with able men which it affords. Contacts with such men have double value to us as teachers of future engineers. Reading of current engineering periodicals and other literature was also advocated. Keeping abreast of developments in engineering, in Professor Laurson's opinion, is highly necessary.

Speaking of preparation for teaching as a career, Professor Laurson stated as his belief that it is desirable to have had one or more years of practical engineering experience before taking up the work of the teacher. This, he believes, would not only give perspective on the whole field of engineering work, but would make the teacher both more human and more systematic. Quoting a facetious remark, he said, "There is

also some satisfaction in feeling that you are not teaching because you can't earn your living honestly," giving this as a further reason for engaging in practice before entering teaching work.

Training a Teacher of Mechanics Should Possess was the topic discussed by Professor N. C. Riggs. Without detracting from other important qualifications, Professor Riggs expressed the belief that teachers of mechanics should be able to handle mathematics with confidence and clearness. This is true because mechanics is a mathematical science. It must be admitted, he said, that mathematics is not sufficient in itself for the solution of any problem in mechanics, but it furnishes the tool and the method of analysis which must always be applied. Professor Riggs also stressed the importance of knowledge of the subject beyond the scope of the courses which the teacher conducts. Coming within the scope of mathematical subjects which, in his opinion, the teacher of mechanics should master, are differential and integral calculus, differential equations, advanced calculus, advanced theoretical mechanics, and potential theory. Such training should, however, be coupled with study of the physical sciences in order that the teacher of engineering students may have in mind always the applications to which the subject he teaches is to be put.

As to means of acquiring advanced training, Professor Riggs advocated at least a year of graduate study. If the young teacher cannot afford the expense of graduate study, Professor Riggs feels that much can be accomplished by purposeful private study. He advocated the formation of informal classes of younger instructors for the study of some book and the holding of regular meetings for discussion. In conclusion Professor Riggs stated that it would be desirable for a few universities to offer a graduate course especially for the training of teachers of mechanics.

Professor Bullard opened his remarks by stating his belief in the fundamental necessity for each teacher to study and understand the mission of the school and department in which

he teaches. In the second place, he believes that each teacher should study the relationship which his course bears to other courses of the curriculum. This can be done through conversation with other members of the faculty, through study of the texts used and by solving for himself the problems assigned in other courses. By doing this, the teacher can impress upon the student the uses which will later be made of the subject which he teaches. As an illustration, he cited the fact that, by themselves, the principles involved in determining moment of inertia mean very little to the student, but if he can be made to realize that such practical problems as those relating to beams, torsion, rotation, stability of ships, and the like, involve the use of moments of inertia, he may be led to appreciate that subject and to desire to master it.

Professor Bullard also expressed the belief that the teacher ought to establish the proper sort of personal relationship with his classes and with individual students. To this end he should study the students, determining in so far as possible difficulties which lead to scholastic failure. In speaking of methods of teaching, Professor Bullard said that he thought that general principles and general methods of attack should be taught first and that the student should be required to follow a prescribed procedure, at least at first. Later he may be allowed to work out his own methods. As a teacher of mathematics, Professor Bullard deplored remarks sometimes made by teachers which lead to weakening of respect of students for the subject. He believes that mathematics constitutes a tool which can be used to very great advantage in all sorts of work. He expressed his personal opinion that the study of pure mathematics is valuable for that reason.

Friday, July 22. Afternoon Meeting

The afternoon meeting was devoted to a continuation of the discussion of the topic *Self-Improvement of the Teacher.*

Professor James E. Boyd opened the meeting by a discussion of advanced work as a means of self-improvement. The young teacher should, in his opinion, first master the subjects

he is teaching, as defined by the limit of the courses taught, and become thoroughly familiar with the methods of presentation employed in the department in which he teaches. As a next step, Professor Boyd advocated advanced study together with a thorough review of the fundamental mathematics and physics on which work in mechanics rests. If possible, advanced study should be taken in regular college courses. If not, it should be pursued independently or by forming small groups of teachers of the same subject or those interested in the same general line of work. Two ways of doing this were mentioned: one by selecting some good book, not too advanced in character, and studying it thoroughly; and the other by selecting a particular topic and studying intensively selections relating to it, including various texts, papers presented before professional engineering societies, original test data, and the like.

Professor Boyd then mentioned research as a means of self-improvement and urged that every teacher of mechanics engage in some research project. These may be of two kinds: one with the purpose of acquiring more knowledge for oneself, and the other of disseminating new knowledge for the benefit of others. The young teacher should, in general, pursue the first of these objectives. "This kind of work," he said, "for a few years is far better as a means of developing you as a teacher than a narrow, time-consuming original investigation can be."

Full-time graduate study was next considered. Those who can do so may find it advantageous to take a full year off and spend it in graduate study. In that case study in a different institution from that attended as an undergraduate may be desirable. Full-time graduate work is not absolutely necessary, however. Advantage may also be taken of summer courses which are now offered by the larger universities in great variety, or the opportunities offered in the institution in which the teacher is engaged may be capitalized by taking one or more courses concurrently with regular teaching duties. This, Professor Boyd said, related to *formal* graduate study.

He assumed that every vigorous teacher would study independently and continuously, whether he pursued formal courses or not.

Professor R. M. Stewart followed Professor Boyd, choosing as his topic *Growing Professionally*. His first observation was that every teacher should continue to study and should derive satisfaction both from the process of learning and from teaching others. Unless he himself delights in study, Professor Stewart asked, why should the teacher desire to instruct others. Continuing this line of thought, he brought out a number of points: That one should (1) set apart some definite time for self-improvement, as such improvement will not come of its own accord nor will much be accomplished if left to leisure time; (2) recognize community needs, that is, see what is most needed and bend one's efforts in that direction; (3) rely on oneself for projecting a plan and executing it; (4) select and follow problems that are worthwhile; (5) select what most suits one's needs, not undertaking something for which one is not fitted but something in which one is intensely interested; (6) whenever possible pursue original studies so that something of real value to society may result.

In the purely American problem of educating everybody, Professor Stewart said, the need for new teachers has become very acute. In this connection he would have the teacher consider the question, "How much am I needed as an individual?" The answer to this question should motivate the teacher in his work.

Professor Stewart advocated the employment of a self-rating scheme or inventory of one's good qualities and deficiencies with a view to the determination of needed efforts toward self-improvement. In this scheme one should compare oneself with another who stands high in a given quality as, for example, grasp of subject matter. Similarly someone should be selected who stands high in some other quality; and so on for whatever qualities comparative rating is desired.

As a third point, Professor Stewart said that the classroom teacher should improve himself by doing research work. This

may be either of two kinds: (1) extra-teaching research, or that which lies outside the teacher's own line of work, and (2) teaching research which is carried on for the sake of improvement of teaching methods.

Professor Stewart raised the question as to what should be studied in the field of education to meet the professional problems of that field. This he referred to under three headings: first, educational psychology, recommending Thorndike's *Psychology;* second, a study of the curriculum, not with the idea of making a new one but with a view to making it fit best the purposes for which it is intended; and, lastly, the critical study of the examination as a method of teaching. This he did not attempt to analyze in full, but thought it should be regarded as the selection of examination methods in accordance with the ends sought in the course. He believes that the examination should test the teacher just as much as it tests the student.

Professor W. S. Franklin then gave some views on the topic, *What Can a Young Teacher Do to Advance Himself Educationally?* He believes that a young man need not wait until he takes up teaching to prepare himself for it, but that he can begin while an undergraduate. Explaining his meaning, he cited cases of students who had gone outside of their prescribed courses to pursue others. Never, Professor Franklin believes, should the young teacher spend his vacations in idleness; he should be studying continually. This he may do by pursuing summer courses, by individual study or by the practice of engineering. Pointing to the fact that some institutions now require their newly appointed teachers, or those who are to be promoted, to hold higher degrees, Professor Franklin mentioned the desirability of graduate study for that reason.

Professor Franklin advised the teacher of physics to read extensively in his own field and recommended a number of books which he believes valuable: *Elementary Physics,* by Poynting and Thompson; *Popular Lectures and Addresses,* by Lord Kelvin; *Philosophy of Science,* by G. N. Lewis;

Grammar of Science, by Carl Pearson; *Theory of the Electron,* by Millikan; *Light Waves,* by Michelson; *Earthworm and Vegetable Moulds,* by Darwin; which were of especial interest to him.

The concluding presentation was given by Professor W. J. Risley. He emphasized the fact that the teacher has not only a privilege in teaching, but is also under a considerable responsibility. In order to execute his task properly, he must ever be alert to anything which pertains to his own field, and to those surrounding it. He should not try to teach unless he can put his whole heart into his work.

If the teacher in his spare time must find recreation from sources external to himself, he misses his aim as a teacher. He should be able in moments of leisure to find relaxation in meditating not only on the ordinary or trivial things of life, but in reaching out into realms just beyond the ordinary and look, as it were, into the future.

In short, Professor Risley said, the teacher should keep his mental, physical and spiritual faculties alert so that he may ever be ready to meet new problems as they arise, and so that he may discharge his duty with credit to himself and for the best interests of his students.

Friday, July 22. Evening Meeting

Parke R. Kolbe: DEVELOPMENT OF UNIVERSITIES.

In his paper President Kolbe traced the development in the form and purpose of universities, beginning with the medieval universities, and considering in succession the English universities; the universities of the United States, urban, municipal, junior college, and city; the early German universities; and the modern German universities.

President Kolbe introduced his remarks by saying that the word *university* does not now mean what it did twenty years ago, that it is used now to designate the "top" of an educational system, and that he thought it might be of interest to consider briefly the changes in purpose, scope, and conduct of universities.

It was pointed out that from the sixth to the twelfth centuries education was largely classical and secular, and carried on mainly in the monasteries; that it was carried on in certain centers and that a few rulers, such as Pope Gregory and Charlemagne, were chiefly identified with and responsible for the work carried on.

The present type of university came into existence in the twelfth century at Paris. The University of Paris was founded by Abelard, who "early became an adept in the art of dialectic, under which name philosophy, meaning chiefly the logic of Aristotle, was the subject of liberal study."

At that time the universities were organized similarly to the guilds, because the world was not peaceable and foreign students banded together primarily for self-protection.

During the thirteenth century the University of Paris was presided over by a rector, and had four faculties: medicine, law, theology and philosophy. The old degree of Master of Arts, as originally granted, was merely a license to teach, the candidate for the license giving a lecture before the staff and receiving approval or disapproval.

President Kolbe remarked that the University of Oxford was probably an outgrowth of the University of Paris; that the early university was a self-governing corporation; and that the German universities, until recently, were thus governed. In France the type of development differed somewhat, the schools of higher learning being more particularly concerned with examination.

Referring to the English universities of the present day, the speaker said that until lately education in England was available to the wealthy only. This, he said, was so mainly because there was no free secondary school system; because of the high cost of attendance at Oxford and Cambridge; because of class distinctions, and the economic conditions of the working people; and because of the distrust of the radical labor element, and the indifference of manufacturers.

It was felt by the speaker that while day work in the English schools was of a very high character, the work in the eve-

ning schools was often elementary. Adult education in England, he pointed out, was now being given to large numbers. As early as 1795 Anderson College was instituted, and by 1830 there were between 500 and 600 mechanics institutes in existence.

University extension work was briefly referred to, this type of instruction having been instituted by James Stuart in England, and by Moulton in this country.

In the opinion of President Kolbe, the concentration of population in cities has had as much effect upon education as any other influence, and has resulted in the development of an urban type of university. In England, Victoria University, founded in 1880, and later the Universities of Birmingham, Manchester, Liverpool, Leeds, Sheffield, Bristol and Reading, all of this type, were founded. Except for Victoria University, all of those named have been founded during the twentieth century. London University (1836), also of this type, was only an examining body until 1900.

In certain of the English cities (Nottingham, Southampton, Exeter and others) what are known as University Colleges exist. These colleges are devoted to teaching, and are not permitted to grant degrees.

In closing his paper, President Kolbe referred to the establishment of municipal colleges in the United States and in Germany. It was his opinion that there would be a slow but steady growth of these institutions with the increasing tendency to concentration of population in cities. The junior college, a still further variation in type of urban institution, he felt was preeminently a school for the smaller cities.

Saturday, July 23. Morning Session

M. S. Ketchum: Structural Mechanics.

Dean Ketchum opened his remarks by expressing great interest in the Summer School as an effort to improve teaching practices. He proposed, he said, to deal with the subject of structural engineering, in which mechanics is largely applied, from the standpoint of improved methods of teaching it.

In structural engineering, Dean Ketchum feels that graphical analysis should be given greater attention. He looks upon the graphical method as an expression of what is essentially an analytical process. The graphical method often enables the student to visualize conditions which he has difficulty in comprehending when expressed algebraically. Influence lines, for example, are of great assistance in visualizing algebraic analyses and in clearing up fundamental concepts. In his own classwork, Dean Ketchum employs both graphical and algebraic analyses, the one serving to clarify the other. He expressed preference in general for procedure from the concrete to the abstract in dealing with students, rather than the reverse process.

Taking up the teaching of graphical methods Dean Ketchum stated that he first begins with the force triangle and then proceeds to the force polygon and the equilibrium polygon. He then elaborated the teaching of these graphical methods and explained the fundamental processes involved. He said, for example, that in constructing the force polygon and the equilibrium polygon two integrations are made; that the equilibrium polygon is analogous to a summation of x components and y components of forces; that every truss is in itself an equilibrium polygon; that both resolutions and moments can be obtained algebraically and graphically; and that moment and shear diagrams are summation diagrams. He here took occasion to refer to the text, *Graphical Calculus*, by Runge, the study of which he recommended.

Dean Ketchum then considered the case of a simple beam bearing a uniform load and demonstrated the construction of shear and moment diagrams and the slope and elastic curve diagrams; pointing out that two integrations had been performed in constructing each set of diagrams. In this connection, he briefly discussed Morley's method of expressing the differential equation of a beam.

From this simple case Dean Ketchum proceeded to the more complex case of a statically indeterminate beam, in connection with which he referred to the moment-area method

of analysis. He also referred to the application of Castigliano's principle, showing how the method of least work may be applied, and indicating the extension of this principle to the case of a curved beam or arch.

Proceeding from this point, Dean Ketchum considered other cases of statically indeterminate structures, developing the equations by which such structures are analyzed and pointing out methods of presentation to classes.

He then touched upon certain general principles and methods of teaching, referring to the job analysis plan as applied to engineering teaching.

Saturday, July 23. Evening Meeting

A subscription dinner as a testimonial to Professor Irving P. Church, was held in Willard Straight Hall. Professor W. J. Risley presided. President Farrand, of Cornell University, Past-President Leland, of the Society, and Dean Ketchum, of the University of Illinois, were also present as guests. The dinner proved to be one of the most enjoyable features of the entire program.

Monday, July 25. Morning Session

W. S. Franklin: The Use of Mechanical Ideals in Electricity.

The purpose of this lecture was to show the parallels which exist between the principles of pure mechanics and the principles of electromechanics. A number of important electrical principles were selected and in each case their equivalence to simple mechanical principles was demonstrated by analysis and by test. Limitations of space do not permit of the inclusion of the entire lecture and a condensed statement is unsatisfactory. Some of the subject matter may be found in the April, 1926, issue of the *General Electric Review*.

J. E. Boyd: DYNAMICS OF CONNECTED BODIES.

Professor Boyd considered several problems of the dynamics of connected bodies and demonstrated how the value of the acceleration of gravity may be obtained by a simple device involving connected bodies. The subject matter of the lecture is given in part in articles 168, 200, 215 to 219, and 235, of Boyd's *Mechanics*.

Monday, July 25. Afternoon Session

At the beginning of the meeting Professor Bullard presented a list of texts and reference works suggested for a review of mathematics which had been prepared by the staff and program committee in response to a desire expressed by members of the conference. The list follows:

TEXTS

College Algebra (Elementary)	Rietz and Cathorne
Higher Algebra	Bocher
Trigonometry, Plane and Spherical	Palmer and Leigh
Analytic Geometry	Riggs
Calculus	Woods and Bailey
Calculus	Townsend and Goodenough
Calculus	Granville and Smith
Advanced Calculus	Osgood
Advanced Calculus	Woods
Calculus for Engineers	Perry
Mathematical Analysis, Vols. I, II	Griffin
Differential Equations	Murray
Differential Equations	Campbell
Differential Equation Problems	Phillips
Mathematics of Engineering	Root

REFERENCES

Vector Analysis	Coffin
Vector Analysis	Silberstein
Spherical Harmonics and Fourier Series	Byerly
Fourier Series and Vector Analysis	Franklin, MacNutt, Charles
Mechanics	Prescott
Mechanics	Jeans
Mechanics	Webster

Graphical and Mechanical Computation.....Lipka
Engineering Mathematics.....Karapetoff

The members then divided into two seminar groups led by Professors Boyd and Rettger for consideration of the topic *Design of Simple Apparatus for Use in Illustrating the Principle of Mechanics.* Numerous simple yet ingenious devices were described or demonstrated, from which many of the fundamental laws and concepts of mechanics may be shown to a class. The effect, in the opinion of the groups, is to assist the student to obtain a grasp of principles and to appreciate their physical significance. It was agreed that simple apparatus is best for use in classrooms, especially if it is to be used in connection with recitations. All of the apparatus described was of a simple nature, but illustrated adequately the effect of suddenly applied loads, center of percussion, transmission of force through a system, simple harmonic motion, determination of moment of inertia, resolution and composition of forces, and other divisions of the subject. Descriptions, sketches and photographs of the apparatus are on file in the office of the Director of Investigations.

Monday, July 25. Evening Meeting

R. E. Doherty: WHAT THE COLLEGE HAS DONE FOR THE ENGINEERING GRADUATE.

Mr. Doherty's paper is printed in full in the December, 1927, issue of the *Journal of Engineering Education,* beginning on page 334.

Tuesday, July 26. Morning Session

W. S. Franklin: THE GYROSCOPE.

This lecture was intended primarily to assist in visualizing the action of the gyroscope. It consisted of a series of experiments designed to illustrate certain fundamental concepts, and of an analytical discussion of several phases of gyroscopic action. Professor Franklin's interesting and

valuable lecture may be consulted in the copy of the manuscript available in the Society's files in the office of the Director of Investigations.

The following resolutions, offered by Professor Riggs, were adopted as indicating the sense of the members of the conference.

> To the Officers of the Society for the Promotion of Engineering Education, who conceived and made possible this Conference, we express our keen appreciation of the opportunity that has been afforded us to participate in this valuable project; and to the Carnegie Corporation of New York, we express our appreciation for the generous contribution of funds which was essential to the successful consummation of the plan.
>
> We offer our hearty thanks to President Farrand, Dean Kimball, Professor Walker, and the members of the Faculty and Administration of Cornell University, who have most happily combined a program of recreation with a schedule of work.
>
> And we acknowledge our deep obligation to the special lecturers and to the Director and members of the Staff of the Conference who have so ably arranged and presented the program.
>
> We believe that the Conference has been of very real value and that its effects will be reflected in improved methods of teaching and in better balanced courses.

A permanent organization was then formed with the purpose of keeping the members in touch with one another and of continuing the studies begun at the conference. Professor Z. R. Bliss was elected secretary of the organization.

J. E. Boyd: MOMENTS AND DEFLECTIONS IN A CLOSED CIRCULAR RING.

Professor Boyd's intention was to illustrate two solutions of a simple problem of slightly greater complexity than those usually considered in courses in strength of materials. The moments and deflections of a closed circular ring subjected to force at opposite ends of a diameter were calculated by the method of least work and the deflections of points in the ring

were determined by Boussinesq's formula. The moment was also calculated by means of a simple modification of the slope method. The slope method was then applied to the problem of the closed circular ring with equal forces acting along three radii, at angles of 120 degrees with each other. The moment at the section of application of one of these loads was found, also the tension across the section. The method of checking the tension by resolutions, was also shown. Means of checking both the moment and the tension by the method of least work were also indicated.

The conference adjourned at 12 noon.

(To be concluded in an early number of the *Journal.*)

DESCRIPTION OF PROCEDURES OF THE PERSONNEL SYSTEM FOR THE SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY, LAFAYETTE, INDIANA.

BY J. E. WALTERS,

Director of Personnel.

(All of the forms, A, B, C, D, E, F, G, I and J, referred to in this description are given throughout this article.)

Introduction and Organization.

The Personnel System of the Schools of Engineering at Purdue University is often called the *Personnel Service* because it is believed that a University Personnel department, in order to be most effective, must be a *service* department and not a *control* department. This service must be of value not only to each school and department, but to each student personally, and to the members of the faculty, by assisting them to help the student. It is not a disciplinary department. It is a place for students to go for personal assistance without fear of discipline. Upon that basis we have endeavored to establish this work.

Historically, the Personnel Service at Purdue was originated by Dean A. A. Potter of the Schools of Engineering, in 1921. Dean Potter has been a student of personnel problems for the past twenty years, and as the result of his constant interest and attention, the system has grown from year to year.

Personnel and employment problems are given major consideration not only by the engineering faculty and personnel staff but also by the President and Trustees of the Institution. For example, during the winter of 1925–26 a ranking member of the Board of Trustees requested the Dean of the Schools of Engineering of Purdue to accompany him on an extended trip through the industrial concerns where Purdue graduates

are employed in large numbers. The objectives of this trip were to determine, among other things, whether Purdue engineering graduates are being exploited; also to pave the way for visits by the Director of Personnel in connection with the program of following up Purdue graduates and adapting them to their life work, engineering in industries.

Shortly after the appointment of the present Director of Personnel, a Committee, composed of the Director of Personnel and one member of the staff of each of the four schools was appointed by the Dean of Engineering upon the recommendation of the Head of each School. This Committee includes:

(1) Prof. H. C. Peffer, as Personnel Representative from the School of Chemical Engineering.
(2) Prof. B. H. Petty, from the School of Civil Engineering.
(3) Prof. C. F. Harding, from the School of Electrical Engineering.
(4) Prof. D. P. Craig, from the School of Mechanical Engineering.
(5) Mr. J. E. Walters, Director of Personnel, Chairman.

The purpose of this Committee is to meet and discuss personnel plans and procedures with a view of making the methods efficient, of giving assistance more specifically adapted to the different schools. The Personnel department has been bettered because of the assistance, guidance and counsel of this committee.

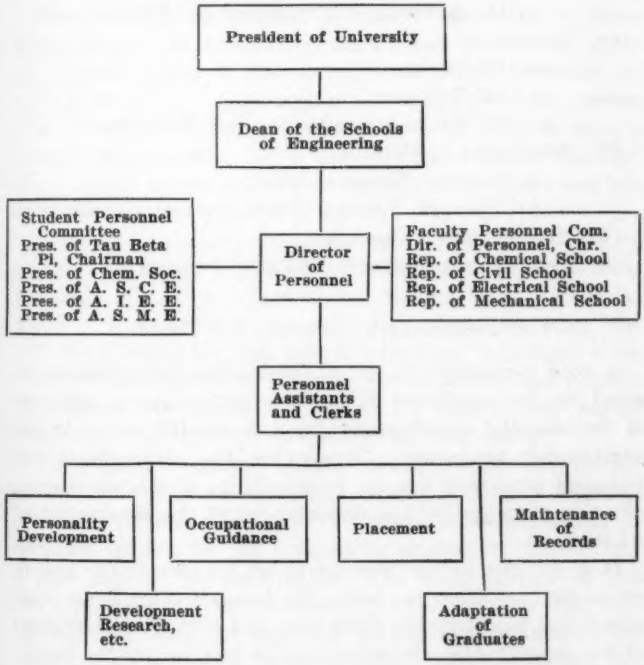
As a result of the fine assistance which the Faculty Personnel Committee gave, a Student Personnel Committee was appointed, composed as follows:

Student President of Tau Beta Pi, Chairman,
Student President of Chemical Society,
Student President of A. S. C. E.,
Student President of A. I. E. E.,
Student President of A. S. M. E.

The purposes of this student committee are to meet and discuss personnel matters with the Director of Personnel; to

give the student viewpoint relative to the Personnel Service; and to make the Personnel Service more effective and useful to the students. Much assistance has been given and many student viewpoints have been made clear by this committee.

The work of the Personnel System is directed by the Director of Personnel, who reports directly to the Dean of the Schools of Engineering. The organization of the Service is shown in the following chart:



ORGANIZATION CHART OF THE PERSONNEL SERVICE, SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY, LAFAYETTE, INDIANA.

Six Classifications of Personnel Service.

The activities of the Personnel Service may be divided into six general classifications, with subdivisions, as follows:

(1) Personality Development
(2) Occupational Guidance
    (*a*) Before Admission
    (*b*) Summer Employment
    (*c*) Harmonizing of Preference and Fitness
(3) Placement
    (*a*) Of Seniors
    (*b*) Of Graduates
    (*c*) Of Students during Summer Vacations
(4) Adaptation of Graduates
    (*a*) Through Progress Blanks
    (*b*) Through Personal Visitation and Coordination
(5) Maintenance of Records
(6) Development, Research, and Miscellaneous

The Personality Development Program.

A good personality is one of the leading requirements exacted by the employers of engineering graduates, and one of the essential qualifications for a successful career in the engineering profession. Considering the above facts the technical university has the responsibility of maintaining an effective program for the development of the personality of its students.

It is difficult for the student to see his own faults and to see himself as others see him. He does not often know what others find objectionable about him, and without a knowledge of his objectionable characteristics he will be greatly handicapped.

What is Personality? It is the quality or state of personal activities or traits, which cannot necessarily be distinguished as either right or wrong. It differs from character in that character is the quality or state of personal activities or traits

which are so distinguishable. Honesty is a trait of character, because it is right to be honest. In other words, honesty is distinguishable as right or wrong. Attitude, disposition and initiative are characteristics of personality, because it is not necessarily wrong to have a poor attitude or a bad disposition, and to be lacking in initiative.

Personality depends upon personal activity for its existence. Without activity it finds no expression and is lost, whether it be good or bad.

Personality is judged by the manner in which it affects other people. A student may have many qualities of a fine personality, but if he does not impress people favorably, he will be judged as having a poor personality. In the personality development program, the student is asked to analyze himself impersonally. How does he affect others? Do they have a good or bad opinion of him after they have met him and after they have known him?

After an application for admission to Purdue has been received, and before registration, the prospective engineering freshman fills out a personnel information blank (Form A) which includes detailed personal information concerning himself, his parents, his high school record and activities; a list of five former employers, business men or professional friends; information concerning his health; his occupational preference; and a *detailed self analysis of his personality.*

He is asked to analyze himself and to rate his own personality by means of a rating scale (Form A, reverse side), on ten characteristics or traits. This rating is not necessarily an accurate opinion by the prospective student of himself, nor a true gage of his personality. The main purpose of this self analysis is to focus the student's attention upon analyzing himself and upon the fact that he has a personality which affects those whom he meets in a very definite manner, and which can be developed.

PURDUE UNIVERSITY PERSONNEL RECORD

Name (In full) ....., ..., ...
Last First Middle
Course ..... Class, 19.....
Date of Birth .....19..... Place of Birth .....
Nationality ..... Color .....
Have you lived in the country? ..... Town? ..... Or City? .....
Parent or Guardian .....
Permanent Address .....
Parents living? .....
Parents' Occupation? ..... Parents' Nationality? .....
Number of brothers? ..... Number of sisters? .....
Names, addresses and relationship of Relatives who are Purdue Graduates .....
.....
Practical Experience or work before entering Purdue .....
.....
Name and address of High School .....
High School Average .....% What scholastic third of your Class? .....
Part taken in Literary, Dramatic, Athletic and Other Activities in High School .....
.....
Hobbies? .....
Studies most enjoyed in High School .....
What percent of your expenses will you have to earn in College .....% How are you planning to do it? .....
.....
To what Church do you belong? .....
If you do not belong, what church do you prefer? .....

Any honors received in High School? .....

To what secret organization or fraternity to you belong? .....

Did you ever plan, design or build a new object? Give details .....

.....

.....

Vocational Preference: What do you expect to do after graduation from College?

1st Choice ..... 2d Choice .....

Health: General Condition ..... Good? ..... Average? ..... Poor?

Physical Defects or Deformities with: Hearing? .....

Speech? ..... Sight? .....

Arms? ..... Legs? .....

Height? ..... Weight? .....

Recent Sickness or Operations? .....

Give below a list of five references from among former employers, doctors, lawyers, friends, etc.

	Name of Reference	Occupation	Address
1.	.....	.....	.....
2.	.....	.....	.....
3.	.....	.....	.....
4.	.....	.....	.....
5.	.....	.....	.....

Remarks: .....

Date ..... 19....., ...

Signature

Self Analysis on Opposite Side

FILL OUT IN TRIPLICATE ON BOTH SIDES AND RETURN AT ONCE

FORM A.

PURDUE UNIVERSITY
LAFAYETTE, INDIANA

Dear Friend:—

Purdue University is interested in developing not only your mentality, but also your character, physique and personality.

You will soon be a student at Purdue. You can aid us and yourself in our efforts to help you derive the maximum benefit from your studies at Purdue if you will grade yourself in the qualities and characteristics of the following list.

The purpose of this is to focus your attention on the fact that you have a personality, that it can be developed, and that you must now stand on your own feet and work out your own future. What you are to become from now on will depend almost entirely upon you, what you do and how hard and well you do your work. This rating will assist you in analyzing yourself. Start now to improve your personality.

Please place a check mark (V) after each characteristic at the place on the scale that you know yourself to be qualified to be rated. If you are exceptionally good put a check (V) under 10. If you are the poorest put it under 1. If you are average check under 6 and if a low average under 5 and so on through the scale. If average place check between 5 and 6.

Grade yourself in comparison to men of similar age, educational preparation and environment. An effort has been made to define each of the characteristics in the following list in order that greater uniformity of rating may result.

Cordially yours,
J. E. WALTERS,
Director of Personnel.

Characteristics	Poor		Low		Average		High		Highest	
	1	2	3	4	5	6	7	8	9	10

Characteristics	Poor		Low		Average		High		Highest		
	1	2	3	4	5	6	7	8	9	10	
1. ADDRESS AND MANNER: (Do I leave a good impression? Do I talk well? Am I popular? Have I a good bearing?)											
2. ATTITUDE: (Am I rational, agreeable to reason, in my views? Interested in my work? Optimistic? Self-controlled?)											
3. CHARACTER: (Am I reliable? Dependable? Absolutely honest? Responsible? Clean? Just? Courageous?)											
4. COOPERATIVE ABILITY: (Can I work with others? Am I accommodating? Loyal? Willing to learn? Tolerant? Tactful? Am I a good mixer?)											
5. DISPOSITION: (Am I cheerful? Courteous? Congenial? Enthusiastic and not conceited?)											
6. INDUSTRY: (Am I a hard worker? Have I perseverance? Am I persistent?)											
7. INITIATIVE: (Am I a self-starter? Do I recognize, start and develop opportunities to a successful conclusion? Am I original?)											
8. JUDGMENT: (Have I common sense? Observing and reasoning power? Foresight? Resourcefulness? Do I know values and the relations of things? Am I practical?)											
9. LEADERSHIP: (Do I understand men and can I command their respect? Have I executive ability? Do I precede and direct men?)											
10. NATIVE CAPACITY: (Am I naturally accurate, systematic, bright, alert? Have I an inherent knowledge of facts and data? Can I concentrate? Do I learn readily? Have I a natural aptitude for work?)											

Remarks: Indicate under this head any additional information which may prove of value. If you have poor health, a deformity, or any peculiarity this should be reported, please note here.

.....

Signature

.....

Address

PURDUE UNIVERSITY FRESHMEN PERSONNEL RECORD.

Name (In Full)....., ... Class..... Course.....
Last First Middle

University Address.....Lafayette W. Lafayette. Tel. No.....
Date and Place of Birth.....19....., ... Nationality.....
Nicknames ..... Color .....
Parent or Guardian..... Permanent Address.....
Parents' Occupation..... Parents' Nationality.....
Practical Experience Before Entering Purdue.....
.....
Part Taken in Student Activities at the University as Freshmen.....
.....
Hobbies..... Studies most Enjoyed at Purdue.....
.....
What percent of your expenses do you earn in college?..... How?.....
.....
To what fraternity or club do you belong?.....
To what church do you belong or attend?.....
Any honors received as Freshman?.....
Membership in honorary organization?.....
Did you ever plan, design or build a new object? Give details.....
.....
.....
Vocational Preference: What do you want to do after graduation?
1st Choice:..... 2d Choice:.....
What do you plan to do next summer?.....
Health: General Condition..... ....
Good? Average? Poor?
Physical Defects or Deformities in:
Speech?..... Sight?..... Hearing?.....
Arms? ..... Legs?.....
Height ..... Weight .....
Recent sickness or operation.....
Remarks: .....

FORM B.

DATA COLLECTION SHEET FOR PERSONNEL RECORD SCHOOLS OF ENGINEERING, PURDUE UNIVERSITY

NAME..... CLASS..... SCHOOL.....
(Last name first)

A. List of five students, from the Engineering Schools and Departments who know you best.

	STUDENTS' NAMES	CLASS	SCHOOL
1.			
2.			
3.			
4.			
5.			

B. List of five Faculty members who have actually had you in class.

	INSTRUCTORS' NAMES	DEPARTMENTS OF INSTRUCTION
1.		
2.		
3.		
4.		
5.		

C. List of five references from among former employers, doctors, lawyers and personal acquaintances (not relatives).

	NAMES OF REFERENCES	ADDRESSES
1.		
2.		
3.		
4.		
5.		

FORM C.

PURDUE UNIVERSITY
LAFAYETTE, INDIANA
OFFICE OF THE DEAN OF ENGINEERING

Dear Sir:—

Purdue University is interested in developing not only the mentality, but also the character, physique and personality of its students.

Mr. ....., an engineering student at Purdue, has given your name to us as a reference. You can aid us greatly in our efforts to help him derive the maximum benefit from his studies at Purdue if you would grade him in such of the qualities and characteristics of the following list as are best known to you.

Please place a check mark (V) after each characteristic at the place on the scale that you know him to be qualified to be rated. If he is exceptionally good put a check (V) under 10. If he is the poorest put it under 1. If he is a high average check under 6 and if a low average under 5 and so on through the scale. If average place check between 5 and 6.

Grade him in comparison to men of similar age, educational preparation and environment. An effort has been made to define each of the characteristics in the following list in order that greater uniformity of rating may result. Leave blank any characteristic which you do not know well enough to rate.

Cordially yours,
J. E. WALTERS,
Director of Personnel.

Approved:
A. A. POTTER,
Dean of Engineering.

(Personnel Form No. P-2021-10-25).

Characteristics	Poor		Low		Average		High		Highest	
	1	2	3	4	5	6	7	8	9	10

(Personnel Form No. 3-20M-10-28).

Characteristics	Poor		Low		Average		High		Highest		
	1	2	3	4	5	6	7	8	9	10	
1. ADDRESS AND MANNER: (Does he leave a good impression? Does he talk well? Is he popular? Has he a good bearing?)											
2. ATTITUDE: (Is he rational, agreeable to reason, in his views? Interested in his work? Optimistic? Self-controlled?)											
3. CHARACTER: (Is he reliable? Dependable? Absolutely honest? Responsible? Clean? Just? Courageous?)											
4. COOPERATIVE ABILITY: (Can he work with others? Is he accommodating? Loyal? Willing to learn? Tolerant? Tactful? Is he a good mixer?)											
5. DISPOSITION: (Is he cheerful? Courteous? Congenial? Enthusiastic and not conceited?)											
6. INDUSTRY: (Is he a hard worker? Has he perseverance? Is he persistent?)											
7. INITIATIVE: (Is he a self-starter? Does he recognize, start and develop opportunities to a successful conclusion? Is he original?)											
8. JUDGMENT: (Has he common sense? Observing and reasoning power? Foresight? Resourcefulness? Does he know values and the relations of things? Is he practical?)											
9. LEADERSHIP: (Does he understand men and can he command their respect? Has he executive ability? Does he precede and direct men?)											
10. NATIVE CAPACITY: (Is he naturally accurate, systematic, bright, alert? Has he an inherent knowledge of facts and data? Can he concentrate? Does he learn readily? Has he a natural aptitude for work?)											

Remarks: Indicate under this head any additional information which may prove of value. If he has poor health, a deformity, or any peculiarity this should be reported, here:

.....

Signature

.....

Address

FORM D.

In the latter part of the Freshman year at Purdue, an information blank (Form B) and a reference blank (Form C) are filled out by each Freshman. He gives the names of fifteen people who know him best—five teachers, five students, and five others—who are qualified to rate him on the characteristics of his personality. These characteristics are indicated on Form D and include: Address and Manner, Attitude, Character, Cooperative Ability, Disposition, Industry, Initiative, Judgment, Leadership and Native Capacity. Personality rating scales (Form D) are then sent to the fifteen references, who are requested to rate the student in comparison with men of similar age, educational preparation and environment, and return the ratings to the Personnel Office. The large number of ratings is asked for so that prejudices of one or two will not greatly affect the total average.

The ratings scale ranges from one to ten. There are five general classifications, poor, low, average, high and highest. High average is six; low average is five; average is between five and six; poor is one; highest is ten, and so on. The rating scale of one to ten is used because the student customarily thinks in tens. As soon as the fifteen references (or as many of them as reply, the average in 1927 was 12) have rated each student on each of the ten characteristics, the ratings are averaged, compiled and recorded on the general personnel record card (Form E). The general impression of the student's personality can readily be seen from the ratings.

If the general average of the ratings of a student of all of the characteristics is in the lowest quarter of the averages of his class, he is called into conference by the Personnel Director (or by a member of the Engineering Staff) during the first part of his sophomore year and asked why he is low, or rather why he has impressed fifteen people as being low, in the particular characteristics on which he has been rated below the average.

The ratings will tell a student how his personality is affecting other people. If he is rated average or below, that does

not necessarily mean that his personality is intrinsically average or below, but it does mean that he is affecting these people adversely. Most people have good personalities if they will only use them properly. A poor personality may be altered into a good one; or a good one which is affecting people wrongly may be made to impress people in its true manner. Observation and constant effort should enable most people to develop a good personality.

When the student is called in for a conference and his personality is discussed, he is advised to begin to analyze himself with respect to each particular characteristic and to find out what he is doing that makes those whom he meets think that he has a poor personality. He is urged to ask himself the questions after each characteristic on the rating scale, to study and develop himself so that he can answer "yes" to each of the questions. His personality is discussed with him at length and practical methods of improvement are pointed out, advised and followed up by reports from the student.

Those in charge of personality development work have been surprised by the intense and enthusiastic cooperation given by the students. Many cases can be cited where within one month's time marked progress in the development of personality of students has been seen.

The following are examples of the development of characteristics of a good personality:

Case No. 1.

Mr. L. was a Sophomore in the School of Mechanical Engineering. The average of the 15 ratings of his personality, in his first year, fell in the lowest quarter of the averages of his class. He was called into the Personnel Office for a conference. The average of the ratings on his initiative was exceptionally low. He agreed with the ratings that his initiative was low. The question was then what could he do actually and practically to develop his initiative. It would have been useless to generalize or to tell him to "go out and originate something or start a new plan of some sort." Generalizations like that fail. During the first interview, after about three quarters of an hour of conversation, he told of

some of the difficulties he was having. We started with three of the difficulties in his fraternity house. One in particular was with the financial policy of the fraternity. He had not thought of working them out himself, nor originating and starting a plan to take care of them. He was asked to think out and bring back to the Personnel Office in two weeks, plans for overcoming the three plans ready to present to the rest of the boys in his fraternity. They were presented, accepted and put into effect. He continued working out his difficulties in other fields and originating and starting plans for overcoming them. Since that time he has originated and started many actual and practical plans of work. The opinions of those who at first rated him low have changed, and the boy himself is certain that his initiative has been developed.

Case No. 2.

Mr. W., a sophomore Electrical, has been rated in the lowest quartile of his class by eleven persons. He was called into the Personnel Office for a conference. He had received an exceptionally low rating in character. His conduct and habits and the impression he was leaving with other people were discussed in detail, and finally, after considerable discussion he admitted that at his rooming house and on the campus he would swear (or "cuss" as he put it) in nearly every sentence that he spoke. He said that he continually told "dirty" stories, talked of "wild women," and dwelt on gambling parties that he knew about that he would not think of going to himself. His associates thought that he was "rotten," and the boy admitted that they had a right to. He had then just come to realize what impression he had been leaving. It took but ten minutes more to straighten out his ideas on that matter. Shortly afterward some of the boys who had rated him were asked their opinion about him and they had completely changed their minds about him and rated him high in character.

Mr. W. had been working for two summers in the maintenance of way department of a railroad. His boss was well liked by the workmen, yet "cussed," told "dirty" stories, etc., continually. Mr. W. picked up the habit from his boss, but it didn't work at college as it has with the men on the railroad.

Since that personnel conference the boy has completely changed in respect to the above difficulty.

Case No. 3.

Mr. S., a Sophomore Electrical, received a very low rating in cooperative ability. When he came into the Personnel Office it was found that he was very timid. He said that he could not meet people and only knew three students at Purdue whom he might call his friends and with whom he could talk at all confidentially. He walked to school each morning alone. He was given the problem of meeting one new person each day; he was asked to walk to school with someone each day and try to find out what that person was interested in and wanted to talk about. After he had met a new person he was to check on a piece of paper whether he had made that person his friend or not. If not, why he had not; and if he had why he had. Further, he was to list the good and bad traits of personality in each of these new acquaintances. The boy cooperated to the fullest and forced himself to meet new people and analyze them. At the end of the first month after the conference he gave the names of twenty-four of his new friends with their good and bad characteristics. He is continuing the plan and if he keeps up that record it is not hard to predict where he will be when he is a senior and afterwards.

If a personnel system does nothing else than focus the student's attention upon improving his personality, it is worth the effort.

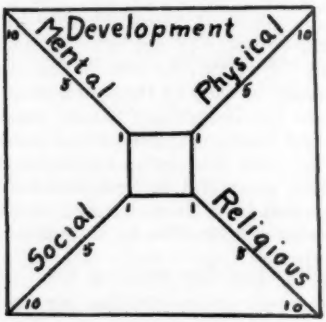
This personality development procedure is repeated in the Junior year. As soon as the data from the references of the third year reach the personnel office they are compiled, and a careful study is made of the ratings, and the opinions are again averaged. After the Junior rating, if the characteristics are not improved the student is called in for another conference. During the Senior year he has another opportunity to improve.

While the personality development program is going on, *the other developments of the student are also being watched,* with reference to *scholarship, health, character and engineering aptitudes.*

In the conferences with the students, full development is stressed and emphasized.

It is customary to say that a man's development is along three main lines—the mental, the physical, and the religious,

but at Purdue the student's development is considered to have four sides: (1) the mental, which is the development of mind; (2) the religious; (3) the physical, which is the development of the body; (4) *and the social, which is the development of the personality.* So, with these four divisions—the mental, physical, religious and social—a personal development diagram, in the form of a square with two diagonals bisected in the center by a small square, is drawn as follows:



Almost everyone has a certain amount of mental, physical, religious and social development and that is represented by the small square in the center. The mental development scale is then from the center square to the upper left hand corner; the physical development scale from the center square to the upper right hand corner, and so on. The student is addressed in somewhat the following manner with reference to his development: "Consider your mental development. How much have you developed mentally in comparison with men of similar age, educational preparation and environment. Mark on the scale at the point upward from the center square to the upper left hand corner where you consider yourself in comparison to the man most highly developed mentally, who would receive 10 as his mark. Do the same thing on the physical, the religious and the social scales. Connect these four points and you will make your development diagram

which, if you are living squarely and developing yourself evenly along all four lines, should be a square." He is asked to develop himself squarely along all four lines.

The above development is considered for every student and a complete record (Form E) is kept in the Personnel Office showing progress in his development in the four phases described above: (1) Every freshman undergoes a physical examination and is graded as to his physical condition. All subsequent sickness and surgical operations are recorded with his medical rating. *Every Engineering student who is sick in the hospital is visited by the Director of Personnel* and assistance is offered. (2) A composite of the student's academic grades is obtained from the Registrar and kept by credit hours and grades, and a general scholastic average figured for each year. A drop in scholarship can be readily detected by these averages and a method of improvement pointed out. The marks made on intelligence tests are also recorded, and are used to assist in giving advice to the student. (3) The personality development program is carried out (previously described in detail), and (4) The religious development is mainly accomplished by the Y. M. C. A. and the churches. The University urges religious development regardless of sect or creed.

From all of the information collected the calibre of the student can be readily analyzed.

In order that a Freshman may adapt himself properly and make the best use of his time he is given a *Study and Work Chart* during the Orientation Period, Freshman Week, and asked to fill it in for everything he does from 6:00 P.M. to 11:00 P.M. according to the following letter and sample schedule:

PURDUE UNIVERSITY

LAFAYETTE, INDIANA
OFFICE OF THE DEAN OF ENGINEERING

MY DEAR FRESHMAN:

Do you want to succeed? You can if you want to hard enough, and if you will work hard enough.

You are now a student of Purdue University and you are the master of your time. How will it be spent?

You should make proper use of every minute you are in the University. Your University career means large financial sacrifices for your relatives as well as for the State of Indiana. You should make every minute count, not just the hours you study, but the hours you work and play.

Your first duty is to study and thereby earn good grades. There is a definite relation between your Purdue grades and your success in life.

The grades of the fifty most successful Purdue graduates were investigated. Every one of those graduates had good grades while in the University. These men are Authors, Presidents of Railroads, Presidents of Universities, Manufacturers, great Engineers and Agriculturists. Your future is unlimited provided you make the proper use of your time.

Attached is a **study and work chart.** Fill in this with a pencil for every hour of the day from 6 A. M. to 11 P. M., just what you are going to do that hour for everything you do, classes, study, work, sleep or play. Do not neglect to have sufficient sleep, in no case less than eight hours out of every twenty-four.

Below is a typical sample schedule for Engineering Freshmen. Fill out your schedule for all days including Sunday, and work to it.

After the first week of use of this schedule, go over it carefully, see where you could not follow it exactly, and then start the next week on the new schedule and follow it. Hand in to the **Personnel Office** (in the Engineering Administration Building) a copy of your schedule on the yellow sheet, as soon as you have made it out after the second week's trial of using it.

Each schedule should be made out with care and **must be made so as to fit each individual's needs.**

If you do not understand how to make out your schedule and want any information about it, I shall be glad to assist you at the Personnel Office at any time between 1:00 and 5:00 P. M.

Very truly yours,
J. E. WALTERS,
Director of Personnel.

P. S. The Personnel Office is located on the first floor of the Engineering Administration Building (the old Electrical Engineering Building), adjoining the Women's Gymnasium.

PURDUE UNIVERSITY STUDENT STUDY AND WORK CHART

(THIS SCHEDULE TO BE KEPT BY THE STUDENT)

Print Name Plainly in Full ..... Smith (Last) George Robert (First) M.E. (Class) 1929 (Course) 220 Waldron (Living Address)

Hours	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
A.M. 6:00 to 7:00	Get up at 6:00, take shower, shave and read the "Exponent"							
7:00 to 8:00	7:00 to 7:30 — Breakfast 7:30 to 8:00 — Study Mechanical Drawing					—		
8:00 to 9:00	Study Mech. Dr.	English	Read at Library	English	Study Math	English		
9:00 to 10:00	Math.	Math.	Material	Math	Math.	Math.		
10:00 to 11:00	Mil. Tr.	Study Mech. Dr.	Mil. Tr.	Study Mech. Dr.	Business Matters	Eng. Prob's.	Sunday School and Church	
11:00 to 12:00	Read at Library	Mil. Tr.	Study Mech. Dr. and English	Study Math. and English	Read at Library	Study Math.		
P.M. 12:00 to 1:00	—	—	Lunch	—	—			
1:00 to 2:00	Shop	Mech. Dr.	Eng. Prob's.	Mech. Dr.	Shop	Recreation	General Reading and Recreation	
2:00 to 3:00	Shop.	Mech. Dr.	Eng. Prob's.	Mech. Dr.	Shop	Recreation		
3:00 to 4:00	Shop	Mech. Dr.	Mil. Tr.	Mech. Dr.	Shop	Recreation		
4:00 to 5:00	Shop	— Recreation —			Shop	Business		
5:00 to 6:00	—	— Recreation —				Business		
6:00 to 7:00	—	Dinner and after dinner chatting				—		
7:00 to 8:00	Study Math.	Study Material	Study Math.	Study Math	Study Math.	Social Affairs	Social and Religious Affairs	
8:00 to 9:00	Study English	Review Eng. Prob.	Study Math.	Study Math.	Study Math.			
9:00 to 10:00	Study Math. or English	Study Mech. Dr.	Study English	Study English	Show at "Lune"			
10:00 to 11:00	—	Retire at 10:00						

SUGGESTED SCHEDULE FOR AN ENG. STUDENT

Conf. Rec. No.

Purdue University Student's Personnel Record

Entered ____ 19__ Graduated ____ 19__

Left ____ 19__ (?) ____ 19__

Name (In full) ____ (Last) ____ (First) ____ (Middle) Class 19__ Course ____ Major Subject ____

Date and place of birth ____ 19__, ____ Nationality ____ Color ____ Nickname ____

Parent or Guardian ____ Permanent Address ____

Parents Occupation ____ Nationality of Parents ____ Parents Education ____ B, ____ S ____

Practical Experience before entering Purdue ____

Name and address of High School ____ What Scholastic third of H. S. Class ____

Practical Experience during vacations, 1st ____

2nd ____ 3rd ____

Student Activities: Freshman ____ Sophomore ____

Junior ____ Senior ____

Hobby? ____ Study most enjoyed at Purdue? ____

New object planned, designed or built? ____

What percent of expenses earned in College and How? Freshman year ____ % Sophomore Year ____ %

Junior Year ____ % Senior Year ____ %

Memberships: Church ____ Social Fraternity or Club ____

Honors and Honorary Organizations ____

Faculty or Committee Actions ____

Vocational Preference: As Freshman, ____

As Junior, ____

Work best fitted for, with reasons ____

Work entered, ____

REMARKS: ____

F. Tel. No. ____

J. Tel. No. ____

F., Univ. Address ____

J., Univ. Address ____

(Photograph and Debris Record in above Space)

PER. P.-328 10-0-37

Form E

	FRESHMAN RATINGS	SOPHOMORE	JUNIOR RATINGS	SENIOR
Scholarship				
Leadership				
Character				
Personality				
Physical Condition				

CHARACTERISTICS	FRESHMAN RATINGS								SOPHOMORE		JUNIOR RATINGS								SENIOR	
	Teachers		Students		Others		Average		Teachers		Teachers		Students		Others		Average		Teachers	
	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No.	Grade	No
1. Address and Manner:																				
2. Attitude:																				
3. Character:																				
4. Cooperative Ability:																				
5. Disposition:																				
6. Industry:																				
7. Initiative:																				
8. Judgment:																				
9. Leadership:																				
10. Native Capacity:																				
Rating Scale: Averages																				

Form E (reverse)

Academic Record	Number of Each Grade and Credit Hours												Gen.	
	H	No.	A	No.	B	No.	P	No.	C	No.	D	No.	Aver.	No.
Freshman Year														
Sophomore Year														
Junior Year														
3 Years Total														
Senior Year														
4 Years Total														

Difficult Subjects? _____

Easy Subjects? _____

Knowledge of Fundamentals	Average	No.	Int. Tests			
General Technique						

Health Record: Medical Rating A, ___ B, ___ P, ___ C, ___ D, ___

Physical Defects or Deformities _____

Hospital, _____, _____, _____, _____, _____,

Recent Sickness or Operation _____

Height 1st _____ ft. _____ in. Weight 1st _____ lbs.

Heigh 2nd _____ ft. _____ in. Weight 2nd _____ lbs.

Occupational Guidance.

Guidance Begins Before Admission.

The Personnel System begins with the high school student by giving him information about "Engineering as a Career," through lectures, and various other contacts on the part of the Engineering Staff with secondary schools. A leaflet on "Engineering as a Career," which has been carefully prepared, contains such subjects as Choosing Engineering as a Career, Qualifications for Success in Engineering, the Preparation, the College Course, and the Work and Pay of the Engineer. A copy of it was sent to every high school senior in Indiana in 1926–27 to make certain that properly qualified high school students have correct information about engineering and engineering education.

Before registration, the applicant for admission is asked on the personnel information blank (Form A) his vocational preference: "What do you expect to do after graduation from college?"—First Choice..... and Second Choice..... If he endeavors to give a correct answer to the questions asked, he is then started to thinking about his occupational preference, a suitable position after graduation and what kind of a position he is best fitted for. Then, as soon as he arrives at the University his Personnel record is started.

The student's preference is the first guide in advising him concerning employment and his life work, but care is taken to make certain that his aptitudes and general fitness are not too much out of line with his ambitions. It is not entirely what a person would like to do but his fitness for a particular career which determines his success. An effective personnel system should be successful in harmonizing the student's vocational fitness with his occupational preference.

Summer Employment in Line of Vocational Preference Serves as Guidance.

Employers prefer men with practical experience. Hence, the Personnel Office assists the undergraduates in securing

employment during their summer vacations. This is particularly true between the Junior and Senior years. An endeavor is made to secure employment for each undergraduate in the line of work he prefers, within the scope of the branch of engineering which he is taking and in the town or city where he lives.

Most of the companies employ engineering graduates after a few short interviews. The employer presents his company in a dignified way, yet he is "selling" his company to the graduate. This does not seem to be a just and proper manner of selecting engineering graduates, for two reasons: First, it is not fair to the graduate, for he usually does not know definitely whether or not he wants the particular work offered by the company until he has tried it; and, secondly, the company does not know from the interviews whether the man will make good with the organization until he has been tried. When a concern accepts a man upon graduation it agrees, to a certain extent, to keep him if he is fairly satisfactory. Nevertheless, he may not be the best man for that company and the company does not know it until they have tried him out on the job and in different jobs.

At Purdue, employment contacts with companies have been set up whereby Juniors and underclassmen will be employed during their summer's vacation, with the understanding that if they are satisfactory to the company, they *may* be offered employment after graduation. This plan aids the student in selecting his life work. It guides him vocationally and gives the company an opportunity to see whether the student is industrious, capable and desirable. This plan has proven satisfactory where it has been tried.

Occupational Preference Should Be Synchronized with Fitness.

The data which have been secured during three years, concerning the student's personality, scholarship, health and personal history, furnish a basis for definite occupational guidance in his senior year.

PURDUE UNIVERSITY PERSONNEL EMPLOYMENT INFORMATION BLANK

.... School ..... Class .....
Last Name Initials

Senior Technical Option .....
Major Subject in Senior Year

University Address .....Lafayette St., W. Lafayette, Tel. No. .....

Have you a satisfactory position which you intend to accept upon graduation? .....

What branch of engineering do you prefer to enter upon graduation? Check first choice with one check (√) and second choice with two checks (√√). Put under your choices the specific kind of work or the particular company you prefer. Read all ten divisions before checking any.

1. Design: .....
   Kind? .....
2. Research: .....
   Kind? .....
3. Communication: .....
   Kind? .....
4. Transportation: .....
   Kind? .....
5. Personnel and Management: ....
   Kind? .....
6. Operation: .....
   Kind? .....
7. Public Works: .....
   Kind? .....
8. Teaching: .....
   Kind? .....
9. Commercial Work and Sales: ....
   Kind? .....
10. Production (Mfg.): .....
    Kind? .....

If the branch of engineering in which you are most interested does not appear on this list please write it here .....

.....

If not interested in taking up strictly technical engineering work, what branch of business or other field would you prefer to enter? .....

.....

.....

Give details of the work you wish and the name and address of the company or companies that you would especially prefer .....

.....

.....

Give your practical experience in the line of work desired .....

.....

.....

What percent of your expenses have you earned in college: .....
Nature of work .....

.....

Remarks: .....

.....

FORM F.

FACULTY PERSONNEL RATINGS OF VOCATIONAL FITNESS

of the members of the

..... CLASS OF THE SCHOOL OF .....

(Please place a check (V) under the kind of work for which each student is best fitted. Rate each student.)

Name	Work Best Fitted for												Knowledge of Fundamentals (Rating Scale: 2, 4, 6, 8, 10)	General Technic (Scale: 2, 4, 6, 8, 10)
	Design	Research	Communication	Transportation	Personnel & Mgt.	Operation	Public Works	Teaching	Commercial & Sales	Production	(Other)			

At the beginning of his last year the student is again asked to make a report (Form F), as to whether he has a satisfactory position in view which he expects to accept after graduation (about 95 per cent of students do not have); what work he prefers to take up after graduation; the particular company he would prefer; and his particular experience and qualifications for that work.

At the same time, at least five instructors are asked to rate each senior as to his occupational fitness, knowledge of fundamentals and general technique (Form G).

About the middle of the school year a letter is written to each senior explaining the value of the personnel service to him as a senior, and asking him to call at the Personnel Office for a conference about his various ratings and his work after graduation. He is then interviewed concerning occupational preference and fitness. In these interviews the students' scholastic record, the personality and other ratings by their fellow students, teachers and others, success in summer employment, as well as the opinions of those teachers who know them best with reference to their occupational fitness are discussed in detail. From such interviews, from previous records, and from conferences with members of the Faculty a record is prepared showing several functional types of work for which each student should be recommended. Thus, a student may be placed as preferring as well as being best fitted for one or several of the following: design, research, communication, transportation, personnel and management, operation, public works, teaching, commercial work and sales, production or construction.

Placement and Follow-up.

The proper placing of an engineering senior in his first suitable position upon graduation is an important and delicate task. Very often this first position influences his whole career as well as his attitude toward industry, the college from which he graduated and engineering as a profession.

The poorly placed graduate usually blames his college preparation and society as a whole for his failure to make good.

The actual placement of Purdue Engineering Seniors is accomplished by (1) visits of representatives of engineering and industrial concerns, working by means of talks before classes, lectures, pamphlets and interviews; (2) letters from companies wanting men, and surveys of positions available, followed up by lists of seniors sent by the Director of Personnel or Heads of the Schools; (3) visits to companies by the seniors.

Each year during the second semester about two hundred representatives from the industrial concerns visit the University, talk before various classes about their work, and interview the seniors for employment with their companies. Sometimes employment is offered during the interview, but usually the definite offer is not made until sometime after the interview, and in practically no case until after the personnel records of men have been investigated, and discussed with the members of the faculty of the schools concerned and the Director of Personnel.

Personnel Service Serves Industrial Concerns.

The Personnel Service is helpful in saving the time of representatives of concerns in connection with the selection of seniors. With about 300 engineering seniors at Purdue University it would be difficult to arrange for interviews of all seniors by representatives of companies. The Bell system and several other large concerns send to the Director of Personnel about the first of the year memoranda specifications concerning their needs for the verious functional branches of their organization. A sample of the specifications as given by the Bell system last year (1926–27) is shown in table on page 484.

The right column refers to a detailed description of the work under each division. An introduction to one of those descriptions immediately follows the table on page 484.

Organization	No. of Men Needed	Course	Description or Nature of Work	Section and Page in "Work and Opportunity"
Bell Telephone Laboratory, N. Y., N. Y.	2	E.E. or M.E.	Development and Research	A, page 16
Western Electric Company, Chicago, Ill.	2	M.E.	Development Engineering in Manufacturing	F, page 42
	1	E.E.	Development Engineering in Manufacturing	F, page 42
Long Lines, Chicago and Middle West	5	E.E.	Transmission and Equipment Engineering	B, page 24 B, page 26 C, page 30 B, page 22
Operating Co., Chicago and Middle West	10	E.E. or M.E.	Engineering of Telephone Plants in Connection with Plant Traffic and Commercial Operation	C, page 30 D, page 34 E, page 38

"It (development and research work with the Bell Laboratories) involves the critical study of the telephone plant and its operating conditions, the formulation of the requirements which must be met by new and improved devices, the development of the instrumentalities to accomplish the desired results and the thorough testing of them in laboratory and field. Equipment and systems must be designed to give the most effective service together with economy in first cost and reliability and economy in operation and maintenance."

This is followed in the description by a detailed story of the work.

The Director of Personnel compares these needs with the records of the students and then in conjunction with the Head or members of the Staff of the particular school or schools concerned prepares a list of students who are interested in the activities of the particular industry and who have the aptitudes for several functional branches as specified by the

prospective employer. The Findex System assists in making these lists. Thus, one large industrial concern communicated to the Director of Personnel in February, 1926, its specification for twenty-two men it was expecting to employ from Purdue University. A list of three times that number was prepared and the representatives of the concern interviewed them and others, and succeeded in interesting seventeen senior students. Another large concern after several years of experience with the Purdue Personnel System, has decided to employ seniors without any interviews by their representatives and entirely upon the recommendation of the Personnel, School and Departmental authorities.

Some companies employ seniors during the second semester to represent them on the campus, presenting their companies to the other seniors, and arranging for interviews with the representatives, and for visits to the companies.

Many companies do not send representatives to the University but simply write asking for the names of seniors and their records. Names are sent to the companies and employment contacts set up.

It is becoming more and more customary to employ engineering seniors only after visits by the prospective seniors to the respective companies at the expense of the latter, in order to give the seniors opportunity to know the companies and vice versa. This is a good plan where the cost is not prohibitive and is highly recommended.

Findex System Assists in Selecting.

The Findex System is utilized in selecting for prospective employers, students preferring the kind of employment offered by the employers and best fitted for their needs.

The complete record of every Engineering senior is tabulated and recorded on a Findex card with 184 classifications, such as class, school, option, grades, personality rating, age, nationality, vocational preference, occupational fitness, etc.

Surveys of Occupations Assist Seniors.

The Purdue Personnel System does not depend entirely upon calls for engineering students from the industrial concerns by visits and requests, but makes surveys every year of the needs of Industries and occupations in Indiana and outside of Indiana, for engineering graduates, seniors and students.

Placement involves not merely getting the senior a job, but getting him a position in the line of work in which he is specializing in the University and which he prefers and is qualified to accept. There are plenty of jobs. The average Purdue senior (1927) had five to eight propositions discussed with him; he had four or five definite offers. Some seniors had as many as twenty-five offers. Others had only one, and three seniors did not have any because of physical defects, etc. The average starting salary for 1927 was $133.00 per month.

The surveys are made in various fields. In the years 1925–26 and 1926–27, surveys were made in Automotive Industry, Aeronautics, Electrical Manufacturing, Public Utilities, Railroads, Refrigeration, Heating and Ventilating, Contracting and Construction, Radio, etc.

As a result of 1,000 multigraphed letters to one field alone, in Indiana, 85 positions were found last year. Seniors were then recommended and put in touch with the positions until employment contact was actually made. Information concerning the companies is also obtained by the surveys for occupational guidance as well as placement. Many fine openings with both large and small concerns, openings which often lead to positions as partners and owners, are uncovered by these surveys.

The Personnel Staff keeps a "Who's Who" of hundreds of companies who employ engineering students. Before a student is encouraged to accept employment with a concern, an effort is made to find out the following details concerning the opening: opportunities afforded to the young graduate for gaining experience, facilities for making full use of engineer-

ing training and of the aptitudes of the candidate, possibility of promotion, accessibility for the young graduate to superiors, and the stability of the concern. Every effort is exerted to protect the young graduate against exploitation, as well as to insure that only those fitted for available vacancies are recommended.

Information Blank Versus Application Blank.

Difficulty and misunderstanding have been encountered with reference to the application blanks given by representatives of companies to Seniors. Some companies wish their application blanks to be considered simply as information blanks, others consider them as application blanks and if accepted by the company make contracts. A few Purdue students signed application blanks with more than one company, considering them all as information blanks. Difficulty followed when two were accepted. Also, the senior in the enthusiasm of youth when writing a letter of application will often over emphasize his qualifications, owing to his high belief in himself. Apparent boasting or egotism does not leave a good impression with the employer.

Misunderstandings concerning the application blanks have been prevented, and a manner has been afforded for students and alumni to present themselves for employment by having printed for their use the Personnel Information Blank (Form J). This gives a complete but brief history of each applicant, with his photograph. A senior or graduate is not advised to sign an application for employment until he knows about the company and is certain that he wishes to go with that concern. He is advised, however, to send the personnel information blanks to the several companies in which he is particularly qualified to be interested, for further information and consideration. He is asked to obtain approval of his information blanks from the Head of his School, so that they may determine whether or not he should send them to those particular companies. He is then asked to write a letter in his own handwriting, forwarding the personnel information to the

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

OFFICE OF THE DEAN OF ENGINEERING

Dear Sir:

Would you mind giving me a report on the work and general development of ..... a graduate of Purdue who has entered your employ.

We are trying to train men to be efficient workers in the engineering field. We are anxious to prepare them for conditions as they are, so that they will waste as little time as possible in adjusting themselves to the needs of the industry. Our whole course is being constantly studied and revised with this point in view. It is important to be able to check up results accomplished from year to year. You can aid us greatly in our efforts by rating such of his qualities and characteristics of the following list as are best known to you.

Please place a check mark (V) after each characteristic at the place on the scale that you know him to be qualified to be rated. If he is exceptionally good put a check (V) under 10. If he is the poorest put it under 1. If he is a high average check under 6 and if a low average under 5 and so on through the scale. If average place check between 5 and 6.

Grade him in comparison to men of similar age, educational preparation and environment. An effort has been made to define each of the characteristics in the following list in order that greater uniformity of rating may result. Leave blank any characteristic which you do not know well enough to rate.

Cordially yours,
J. E. WALTERS,
Director of Personnel.

Approved:
A. A. POTTER,
Dean of Engineering.

FORM I.

Characteristics	Poor		Low		Average		High		Highest	
	1	2	3	4	5	6	7	8	9	10

Characteristics	Poor		Low		Average		High		Highest		
	1	2	3	4	5	6	7	8	9	10	
1. ADDRESS AND MANNER: (Does he leave a good impression? Does he talk well? Is he popular? Has he a good bearing?)											
2. ATTITUDE: (Is he rational, agreeable to reason, in his views? Interested in his work? Optimistic? Self-controlled?)											
3. CHARACTER: (Is he reliable? Dependable? Absolutely honest? Responsible? Clean? Just? Courageous?)											
4. COOPERATIVE ABILITY: (Can he work with others? Is he accommodating? Loyal? Willing to learn? Tolerant? Tactful? Is he a good mixer?)											
5. DISPOSITION: (Is he cheerful? Courteous? Congenial? Enthusiastic and not conceited?)											
6. INDUSTRY: (Is he a hard worker? Has he perseverance? Is he persistent?)											
7. INITIATIVE: (Is he a self-starter? Does he recognize, start and develop opportunities to a successful conclusion? Is he original?)											
8. JUDGMENT: (Has he common sense? Observing and reasoning power? Foresight? Resourcefulness? Does he know values and the relations of things? Is he practical?)											
9. LEADERSHIP: (Does he understand men and can he command their respect? Has he executive ability? Does he precede and direct men?)											
10. NATIVE CAPACITY: (Is he naturally accurate, systematic, bright, alert? Has he an inherent knowledge of facts and data? Can he concentrate? Does he learn readily? Has he a natural aptitude for work?)											

Remarks: Indicate under this head any additional information which may prove of value. If he has poor health, a deformity, or any peculiarity this should be reported, here:

.....

Signature

.....

Address

FORM I.

PERSONNEL INFORMATION BLANK

Issued by the Personnel Service, Schools of Engineering, Purdue University, Lafayette, Indiana; J. E. Walters, Director of Personnel

Name in Full _____
Last First Middle

Course _____ Class of 19

Technical Option _____
(Major subject in Senior Year)

Age _____ Height _____ Weight _____

Nationality _____ Color _____

Married or Single _____ Dependents _____

Father's Occupation _____

Paste small Full Face Photograph Here.

Education:	Name of School	Course taken	How long	Year Graduated
High School				
University	Purdue			
Other Universities				
Correspondence Courses etc.				

Church Membership or Preference: _____

Honors or Honorary Organizations: _____

Social Fraternity, Lodges and Secret Org. _____

Percent of your expenses earned in college, _____ %. How? _____

Scholarship Record: What fourth of class _____, _____, _____, _____, Grades

1st 2d 3d 4th

Hs Ex.	As 95%	Bs 85%	Ps 75%	C Cond	D Fail.	Av.

Athletic, Campus and Other Activities _____

FORM J.

Practical Experience:

With Whom	Kind of Work	How Long
(1)		
(2)		
(3)		
(4)		
(5)		

Personality Ratings in University, Average:

Poor		Low		Average		High		Highest	
1	2	3	4	5	6	7	8	9	10

Health Record:

Kind of Work Wanted

Salary expected:

References: Name	Address	Occupation

Remarks:

FORM J.

companies. Thus the seniors are afforded an opportunity to present their credentials in a dignified manner.

Form J is also used for placing graduates who want to and should make changes in positions.

Adaptation of Recent Graduates to Their Work Proves Helpful.

The responsibilities of the engineering college to its recent graduates do not terminate with the location of the first position. The first two years after graduation from college are without question the hardest for the young engineer. During the entire school and college life he has been accustomed to being constantly brought into contact with new experiences. In his first job he finds little variety and much plain drudgery. He is impatient, or over ambitious to climb quickly to his goal, while his superiors in most cases, are unwilling to give the young graduate sufficient time and consideration to adjust himself to his first position. The college should follow his progress in industry for at least two years after graduation.

At Purdue University a progress report blank (Form I) is sent to the employer of every engineering graduate about fifteen months and thirty months after graduation. If this report is unsatisfactory an effort is made to communicate the findings to the engineering graduate in a tactful manner and with suggestions for improvement.

Information Concerning Positions Available is Given to Alumni.

Each month in *The Purdue Alumnus,* the alumni publication of Purdue University, there appears a page or two of the positions available for Purdue Alumni. The Alumni are asked to write to the companies listed and to send copies of their letters to the Director of Personnel. As soon as letters asking about positions or copies of letters are received at the Personnel Office, personnel information blanks (Form J) are sent to the writers with a request that they be filled in and returned. The positions available and positions wanted are

then checked to each other by the Director of Personnel and recommendations are made to both the companies and the graduates concerned.

Direct Contact between University and Companies through Personnel Director Assists Follow-up Program.

To improve the follow-up system, the Director of Personnel devoted practically the whole summers of 1926 and 1927, and several weeks during the winter of 1926–27 to visiting concerns where recent Purdue graduates are employed. He remained two to six days with each company. The first part of his visit he devoted to actually working with recent graduates. He went through the same employment procedure as is expected of the young engineering graduate, including the filling out of blanks, taking examinations and actually working in departments where young graduates are assigned. The last portion of his visit was spent with the personnel staff and other officials of the organizations, and in getting to the bottom of the difficulties of the recent graduates, smoothing out misunderstandings, obtaining complete personnel and occupational information, learning the policies of the companies and taking up such details as appeared to be disadvantageous to the young graduate. Some of the advantages of such contacts and of smoothing out difficulties are illustrated by the following examples:

(1) Mr. P., a Purdue graduate of the Class of 1926, had just finished the apprentice sales course in one of the leading rolling mill companies. He had been working in the international division of the Sales Department for a short time. His superintendent said that he was doing fine work, that he was bright and had all of the characteristics of a good man, but that he was too fresh. It was found that he was calling by their first names, his boss, his superintendent and even the president of the company. They were holding him back and not advancing him as fast as they could because of it. Mr. P. was interviewed about his manner. He said that they had told him to act just as though all in that department were one family and to be as friendly as he could. He asked, "Why didn't they tell me about it?" The next

day Mr. P. apologized to his boss and his superintendent for what he had done, and they had a long talk about his work. The boy had a new incentive. He was doing so splendidly that in two months he was given a place of considerable responsibility.

(2) Mr. B., a 1922 graduate of Purdue, was assistant to the superintendent of the research department of a large company. His superintendent had been sick in the hospital for some time. Mr. B. had requisitioned some material for the department over the head of his superintendent and urged that it be given before his superintendent returned. The material was given to him and the plan proved successful. Knowledge of this act reached the superintendent and other superintendents of the company and they were displeased. Mr. B. was interviewed about this by the Purdue Personnel Director. The next day he went to his superintendent, apologized and talked things over. Both were working together more strongly than ever within two weeks, and in another month Mr. B. had been promised the position of superintendent on the promotion of the present one.

(3) Mr. K., a 1925 graduate of Purdue, was not getting along very well in his work in the sales department of one of the leading industrial concerns. He had been very hard pressed for funds and upon being urged by his wife had demanded a raise in salary even though he did not deserve it, as viewed by his superintendent. He was held back because of his impatience and others were given the opportunities. The whole thing was discussed with Mr. K., his wife and the superintendent. The next day Mr. K. had a long talk with the superintendent and apologized for his actions. Before another week had passed Mr. K. was doing better work.

Many of the recent graduates were helped during these follow-up trips of the Personnel Director and the reactions received from industry as well as from recent graduates indicate that the follow-up system should be continued and extended. Besides the direct value of assisting the recent graduate to adapt himself to industrial conditions *other results were obtained,* as follows: (1) the information gathered during such contacts and visits is most helpful in guiding seniors in connection with the choice of their first positions; (2) the nature of the work which the graduates were entering was determined (it was found to be largely sales engineering);

(3) arrangements were made whereby the companies would take Freshmen, Sophomores and Juniors during their summer vacations for practical experience and occupational guidance in the line of work which they were taking at the University; (4) closer cooperation between the University and the Companies was effected; (5) some of the companies were assisted in many cases with their personnel and other problems; (6) it was definitely determined that the engineering students should be physically fit to accept the best position offered to them upon graduation and that they should be physically examined periodically and developed while in college; (7) courses were suggested for better adapting the graduates to industry.

Maintenance of Records.

Master Records Are Kept in Personnel Office; Duplicates in Schools.

It is one of the duties of the Personnel Office to keep complete and up-to-date the personnel records of every engineering student in the University, to keep in good running order the programs as described before under Personality Development, Occupational Guidance, Placement, etc. The master record is called the Student's Personnel Record, and all other records are briefed and tabulated on this master record (Form E).

It is the endeavor of the Personnel Office to see that the proper amount of information is given to the Head of each School concerning the students.

The plan approved by the Personnel Committee is as follows:

1. The Personnel Service shall have in the hands of each School Head, the Student Personnel Record of every person who made application for enrollment in engineering. This includes something of the student's personal history, self-analysis, photograph, and other details of value to the Head of the School.

2. By February 15, of each year, the Personnel Office en-

deavors to have in the hands of every School Head copies of the personnel records of the members of the Senior class who are enrolled in his school.

3. The Personnel Service plans to send to the Head of each School at the beginning of the Sophomore year (every September) the personnel records of every Sophomore of his school. It is then expected that each school will compare this record with the record in the Personnel Office at least once a year to bring it up-to-date.

Samples of the forms and records used are shown throughout this bulletin.

A *confidential record* is maintained for those students who prefer it. Students knowing that such a confidential record exists have been freer to tell of some of their escapades, when they would hesitate otherwise to tell, such as stealing at the local gas station, drinking, etc.

Development, Research and Miscellaneous.

The development of the Personnel Service and *the research* conducted by it may be stated briefly as follows: (*a*) the development of a personality rating scale more adaptable to the use of the student, and more easily used by all; (*b*) the development of a rating scale which will show the development of each student in mind, body, character and personality; (*c*) the making of a personality test; (*d*) correlations of personality ratings, grades and intelligence tests and their regression lines; (*e*) personnel statistical methods. These are not sufficiently developed to make a detailed description.

A survey of college Personnel Systems was made by sending to the presidents of over one hundred universities letters asking them to send information about their personnel systems and the forms used. The information leaflet and the forms used in the Purdue Personnel System were enclosed with each letter. Responses were received from about thirty-five per cent; of that number only about ten universities who answered had a system which resembled a personnel system and only three had a separate personnel department or service doing personnel work by intention.

A *personnel conference room* has been established on the second floor of the Engineering Administration Building for the use of the representatives of industrial concerns who interview seniors.

"Worth Remembering Bulletins" have been issued by the Personnel Office at irregular intervals emphasizing the personal development of the student. The titles of such bulletins have been "Are you Living Squarely?," "Do you wish to live a long time?," etc.

Mental hygiene has been stressed in conferences with the students. The Director of Personnel in dealing with apparently "dumb" students has often with the assistance of the Purdue Health Service, found many cases of mental ill health and difficulties unthought of before, have been discovered and overcome.

THE ENGINEER IN HIS CIVIC AND PUBLIC RELATIONSHIPS.*

BY PAUL CLOKE,

Dean of College of Technology, University of Maine.

Now I hold it is not decent of a scientific gent
To say another is an ass—at least to all intent;
Nor should the individual who happens to be meant
Reply by heaving rocks at him, to any great extent.
For, in less time than I write it, every member did engage
In a warfare with the remnants of a palæozoic age;
And the way they heaved those fossils in their anger was a sin,
Till the skull of an old mammoth caved the head of Thompson in.
—*Bret Harte.*

In discussing this question I feel somewhat in the position of the small boy who having placed a chip on his shoulder dares another to knock it off.

I felt a certain pride in having the University of Maine represented on this program and having made the suggestion I found myself in the position of having to defend my thesis.

I have done a great deal more thinking on this question since living in the West than all the previous part of my life. In Arizona where I have spent the past eight years previous to coming to Maine, the density of engineering population is not so great as in New England and when engineers meet each other, as a rule, matters of economic and political import are the most interesting topics of conversation. Again there is something in the free winds that blow in the wide open spaces and in the contemplation of vast solitudes that clears the mind of mental cobwebs and allows clear thinking.

Engineering as we understand it to-day, as we all know, is the result of a gradual development through several stages

* Presented at the 35th annual meeting of the Society, June 27–30, 1927.

and phases. What some engineers apparently are not aware of is the present status of modern changes and phases and particularly their import.

A too close application to the technic of engineering has given engineers a reputation of aloofness in public affairs and even of inability and non-adaptability to the responsibilities of public office, so that it is not an uncommon notion that they are neither by training, temperament, or ability suited as leaders in our public, civic or political life. We have plenty of evidence of this aloofness. Looking over the records I failed to find a single engineer in Congress from the state of Maine since the founding of the Constitution.

How many engineers do you find on important public commissions or in politics? You will doubtless find many good reasons for the existence of these conditions, but does that excuse the engineer or relieve him of the responsibility?

President Roosevelt said, "I want you to feel that it is your duty as well as your right to take part in politics, and not merely your duty to the state, but it is demanded by your own self respect, unless you are content to acknowledge that you are unfit to govern yourself and have to submit to the rule of somebody else as master—and this is what it means if you do not do your own part in government."

This aloofness has led to unfortunate results in other directions as well, such as the assumption of title "engineer" by men in no way qualified and in work which has scant if any relation to engineering. This has led to the creation of undesirable public opinion.

The opinion was expressed by several members of the Maine State Legislature last winter that the employment of architects and engineers on public buildings was an unwarranted expense. I have heard the statement on many occasions that engineers are unsuited for public office as they are too narrow, too hide-bound to a red-tape fetish and a severe orderliness and system in the management of affairs.

Further evidence is found in the public attitude toward public utilities and water power development. Again the

attitude of men of letters such as Vachel Lindsay in his poems on Niagara Falls has served to mould public opinion and the archaic attitude existent on some campuses of the attitude of the liberal arts college towards engineering is too well known to need comment.

The salvation of modern civilization as set forth by H. G. Wells in his "The World Set Free" is from a scientific standpoint ludicrous to say the least. Such an arraignment must needs make us pause and think, examine the facts, draw our conclusions and apply the remedy.

The results of the fact finding investigation of the Society for the Promotion of Engineering Education show that as far as technical work is concerned we are doing a good job, but is it enough for a man to possess the creative and visualizing instinct simply in its application to inanimate things. Is not something more demanded?

In other words are we going to allow such men as Wells to do our dreaming of world affairs for us in the quasi-scientific fashion that he assumes?

When Huxley visited our shore in 1876 in the course of an address he made the following remarks:

"To an Englishman landing upon your shores for the first time, traveling for hundreds of miles thru strings of great and well-ordered cities, seeing your enormous actual and almost infinite potential wealth in all commodities, and in the energy and ability which turn wealth to account, there is something sublime in the vista of the future. Do not suppose that I am pandering to what is commonly understood as national pride. I cannot say that I am in the least impressed by your bigness or your material resources as such. Size is not grandeur, and territory does not make a nation. The great issue about which hangs a true sublimity and the terror of overhanging fate is, what are you going to do with these things? What is to be the end to which these things are to be the means? You are making an experiment in politics on the greatest scale that the world has ever seen. Forty millions at your first centenary, it is reasonably to be expected that

at the second these states will be occupied by two hundred millions of English-speaking peoples, spread over an area as large as that of Europe, and with climates and interests as diverse as those of Spain and Scandinavia, England and Russia. You and your descendants have to ascertain whether this great mass will hold together under the forms of a republic and the despotic reality of universal suffrage; whether state rights will hold out against centralization, without separation; whether centralization will get the better without actual or disguised monarchy, whether shifting corruption is better than a permanent bureaucracy, and as population thickens in your great cities, and the pressure of want is felt, the gaunt spectre of pauperism will stalk among you, and communism and socialism will claim to be heard. Truly America has a great future before her; great in toil and care and in responsibility; great in true glory if she be guided in wisdom and righteousness; great in shame if she fail. I cannot understand why other nations should envy you, or be blind to the fact that it is for the highest interest of mankind that you should succeed."

Certainly much of his predictions are already realities and as we look into the future we can see clearly the rôle of the engineer in ever-widening fields of activity.

The new phase with which engineering has to do nowadays is the entering of engineers into managerial and executive positions and in city planning and zoning and government and city management. As Sam Lewisohn in his book, "The New Leadership in Industry," states, "The political scientist has been found useful in advising the politician. Likewise, the industrial scientist, analyzing the results of industrial experiments, can suggest principles to guide the economic leader."

The work of such men as Herbert Hoover, many engineers who now occupy college presidencies, engineers in city government, city planning, and particularly the increasing number of men who are being drawn from the engineering ranks to fill managerial and executive ranks in industry is ample evidence that the engineer is singularly and peculiarly fitted

for such work. The training in technology, the development of accurate, logical, clear thinking, the vision, adaptability and versatility of the man combined with an association with men in all walks of life fit him admirably for such a job. He understands the laboring man as well as the polished scholar. This understanding gives him a perspective and insight on life which is the lot of few men. I have known men who, having spent a great portion of their lives as teachers of engineering, have made marked successes in even such a prosaic calling as bond selling.

Enough of facts to show that the engineer can discharge his full duty to society. As to some of the means to more adequately train him to meet the demands of the larger leadership which is falling increasingly to his lot.

I think that engineering degrees should be standardized and protected and I am in agreement with Dean Leland on this question as expressed in his paper at the meeting of the Association of Land Grant Colleges and Universities at Washington last November. The essence of Dean Leland's proposal is: for a four-year engineering course give the degrees B.C.E., B.E.E., etc. The graduate degree would be M.C.E.; M.E.E., etc., and finally the degrees of D.C.E.; D.E.E., etc.

Certainly if we are not in agreement among ourselves we can scarcely expect a none too indulgent public to have a settled opinion concerning an engineering degree.

Oftentimes public opinion is created and a favorable reaction made on students as well as widening spheres of influence opened up by teachers of engineering taking up public service work, such as work in the Chamber of Commerce, Community Welfare, City Planning, etc.

The engineer must not study economics and science as abstract subjects but what is much more important the relation of economics to science and vice versa. The time-honored definition of an engineer no longer holds as he must now include the scientific management of men as well as science applied to inanimate things.

That is the reason why we see economics courses creeping

into engineering curricula and the reason for the so-called courses in business administration but it is a serious mistake for schools to set up courses in business administration with the end in view of turning out students who intend finally to go into executive and managerial positions in industry. Those men must have sound technical training and the course primarily must be a technical one.

The proper orientation of these courses and curricula is of course a debatable question. No one doubts the necessity of such studies in engineering who has given much thought to modern engineering.

Sam Lewisohn in his book above referred to says:

"It is therefore particularly important to note that more and more, those who are given the responsibility of managing local industrial plants are graduates of technical schools. It is becoming increasingly evident each year that a large part of the industrial leadership of the country must come from the engineer-managers. Dean Kimball, of Cornell, estimates that 75 per cent of the graduates of engineering colleges subsequently occupy managerial positions in industry. This is due in part to the fact that business is changing from the small employer-owned business to the large business run by trained salaried men, the graduates of technical schools. In larger part the infiltration of such men is due to the increasingly technical aspects of our modern production methods.

"This tendency probably will continue, for large-scale production methods are spreading and are lending increased importance to labor-saving devices."

I am glad to have some issues more sharply defined, as a result of the S. P. E. E. investigations, such as the purposes of teaching English to Engineers for example. Not that we did not know before that an engineer should be able to write and speak clearly and forcibly but there is some comfort in the thought that a certain vagueness which has surrounded this much debated question has been largely dispelled.

I will not take time to go into details with which we should all be familiar but I was particularly struck with one thought.

"The point is, that if English is to be an integral and indispensable element in the curriculum of the first year, it must not be thought of by either teacher or student—and certainly not by the dean—as a course, but as a *Developmental Experience*—a splendid opportunity to stimulate the growth of new habits of thought and expression which should have an immediate and a permanent value."

Probably it is too much to hope for that new ideas will find a warm and ready reception in older minds but certainly much may be expected of our youth of to-day, and it is up to the older successful men to assist in every possible way the young engineers coming up so that they may meet their full duty to society and as citizens.

THE RELATION OF ECONOMICS TO THE WORK OF THE ENGINEER.*

BY JOHN H. ASHWORTH,

Professor of Economics, University of Maine.

Since there are many phases of economics and all kinds of engineering and since I am in no sense an engineer, this paper will, of necessity, be of a very general nature. Professor Comstock on Monday afternoon said that "Many people like to discuss learnedly the thing they know the least about." I shall take warning and steer clear, I hope, of any intelligent attitude toward engineering. If, in so doing, I should seem to stress my own subject unduly, please remember the weaknesses of most teachers and bear with me.

In order to present my topic from more than one viewpoint, I have tried to find out what engineers, in the universities, and out, have been thinking, saying and doing about it. I will recall for you what some members of this organization have said.

Dean Walker of the University of Kansas said upon one occasion: "Engineering deals with agencies employed by large aggregations of capital and with municipal and other governmental institutions. The individual citizen does not employ engineering talent save as it represents large masses of capital. By this token engineering is the profession of organized social and economic forces of modern life."

Mr. H. P. Hammond, your Associate Director of Investigation, has reported that "Returns from recent and older graduates indicate a very marked and almost universal feeling that engineering courses should give more or better courses in business procedure. . . . The desire for training of this character in engineering courses is so widely expressed and confirmed

* Presented at the 35th annual meeting of the Society at the University of Maine, June 27–30, 1927.

in so many ways that it would seem to suggest early and careful attention to this phase of engineering."

Professor Lewis W. McIntyre has summed the matter up as follows: "A knowledge of economics and political economy is necessary to solve properly practically all the routine problems of his every day practice. It is necessary, if he expects to reach the top in his profession and take his place with the leaders of men. It is an aid to that broad culture without which no man can enjoy life except in a very limited way; and it is necessary if the engineer is to take his proper place in public affairs and in the government of his country."

In 1919 at a conference on Commercial Engineering, called by the United States Commissioner of Education, it was recommended that from twelve to eighteen hours in business economics be required in all engineering courses. The following courses were recommended: General Economics, Cost Accounting, Business Organization and Business Law. It was further recommended that a curriculum providing a minimum of from fifteen to thirty units in business economics be incorporated in all engineering courses and offered on an elective basis.

At one of your recent conventions the following resolution was presented and, I believe, adopted: "A thorough course should be given in general economics and another in engineering economics. Practical courses in business should include such matters as accounting, business law, finance and business principles."

Though these suggestions and recommendations have not generally been accepted by engineering faculties, the discussion among engineers of economics for engineering students has borne fruit. In Harvard, Yale, Dartmouth, Columbia, Purdue and other leading engineering institutions, more and more economics is being offered and required in the engineering curriculum.

Since engineers have studied this question so intelligently and so thoroughly, and have begun to act accordingly, it seems almost presumptuous for me to carry the discussion further.

But since I am expected to do so, perhaps I can add a few thoughts to strengthen the position already taken by you.

A survey of the outlines of courses in college catalogues would certainly not lead to the conclusion that there is any relation whatever between economics and the work of an engineer. However, from the standpoint of what engineers do and hope to do, aside from the technical phases of their work, and from the standpoint of the relation of the work of engineers to the work of other people, there are such relations, direct and indirect.

I shall discuss these relations under two heads: first, economics for the engineer as a citizen in relation to his progress and accomplishments; second, the relation of economics to the work of an engineer as a business man and as an industrial leader. We shall take these up in order.

What we in a very general way call economics or principles of economics was originally known as political economy, that is, the economy of the state. The old name should be retained because the course is usually approached from the political or the citizenship viewpoint. For instance, in Taussig's "Principles of Economics" the different parts of the volumes are given the following titles: The Organization of Production, Value and Exchange, Money and the Mechanism of Exchange, The Distribution of Wealth, Problems of Labor, International Trade, Problems of Economic Organization and Taxation. A knowledge of the problems growing out of these general headings is necessary to the fulfillment of citizenship privileges in a democratic country. In America we have blundered along quite a while boldly assuming that any one who reaches the age of twenty-one is capable of voting on any problem whatsoever. With this in mind Lord Bryce once said: "God takes care of little children and America." But the time is soon coming when an intelligent understanding of public affairs on the part of college graduates will be vital in the welfare of the American republic.

The engineer who is familiar with the social and economic organization of his community and his state, and who has an

intelligent understanding of the political problems of his country, is in a much better position to make contacts that lead to contracts than is the engineer whose life is bounded by the relatively narrow circle of his own profession. But all success is not measured in dollars and cents. Engineers, like other men, have aspirations to build their own monuments in terms of public achievement through public service. Dean Walker must have had this in mind when he said: "Engineering is the profession of organized social and economic forces in modern economic life. By nature and tradition it is associated with public interest. Public service is its primary function."

The basic principles of modern life are economic. Production, and exchange in short economic activities, looking to the social and individual welfare, consume the greater portion of our wakeful moments. The better we understand this economic organization and these economic activities of ours, the better we can serve ourselves and mankind. The engineers who can think deep and straight on political problems will lead the people and meet other leaders on terms of equality. Such engineers are the men who help most their community, their state and their country with those wonderful and tremendous projects which are a boon to mankind.

Engineers have played their part in the advent of modern industrial methods which have brought vital social and economic changes. And now the country is expecting them to help solve the all important problems which have resulted from the changes which they helped to bring about. To do this it will be necessary for students to give attention to such problems while their minds are plastic and free from social and political prejudices. I now turn to the relation of economics to the work of an engineer as an industrial leader. The progressive engineer is becoming more and more a leader in the promotion and operation of business concerns. His technical skill, his accuracy of mind, and his habits of work enable him to obtain and hold a strong position in the industrial life of a nation. But good training in economics, es-

pecially in the economics of business, cannot do otherwise than facilitate his advancement as an executive and strengthen his position in industry. There is a tendency to minimize the value of economic training in the preparation for a business career. It is said that "business sense" comes from experience and not from the theory of textbooks and class rooms. It is true that business economics does not make first-class business men but it helps by laying a foundation of fundamental business principles and business procedure. It is equally true that college training in engineering does not make great engineers but it helps by laying a very strong foundation.

Experience is a good teacher in business but a knowledge of business obtained from a few courses in economics will prevent some of the bruises and fatalities which often come in learning by experience. Some knowledge of accounting, for instance, may save some sad experiences on the part of the man who is forging ahead toward a business career. Such topics as the balance sheet, the income statement, reserves, sinking funds, partnership and corporation problems are the business barometers, some knowledge of which helps executives steer clear of business shoals. Any man aspiring to industrial leadership ought to be in a position to examine wisely and interpret well the records of his accountants.

The business engineer is a man who makes contracts, who employs agents and acts as an agent. He has business relations with corporations and partnerships; he forms partnerships and promotes the formation of corporations; he deals in negotiable instruments and mortgages, with guarantee and suretyship. Consequently, the legal principles of modern business, as found in a good treatise on business law, will enable him to meet people in a business way with firmness and confidence.

A knowledge of such problems as the promotion, financing, incorporation and capitalization of industrial corporations; the relation of stockholder and director; stock speculation, receiverships, and reorganization are indispensable to the modern man of business. If the engineering student is grounded

in these things in a course in business finance, his advancement to the front in his profession and as an industrial leader should be made more rapidly and more surely.

But why go further into money and banking, labor problems, public finance and other subjects? Here are the fundamentals of business and every engineer is in some sense a business man.

Realizing the truth of these things, engineering schools are including more economics courses in their curriculum and are establishing courses in administrative engineering. For instance, at Yale University, the principles of economics, accounting, business finance, and business law are required of all engineering students. There has also been established a new four-year graduate course in administrative engineering. Why has this been done? I will answer in the words of Professor J. C. Tracy. "It has been said that the number of distinguished Yale products who are following engineering pure and simple is relatively small. If this is so, I think that the explanation is that many of our graduates who become successful engineers are drafted, so to speak, for responsible positions in industry. . . . Statistics show that a large percentage of our graduates become executives. . . . In response to a demand which became insistent we have established a course in administrative engineering, the object of which is to prepare men for business executives."

DISCUSSION: A SUGGESTED METHOD OF PRESENTING NEWTON'S SECOND LAW OF MOTION.

T. F. Hickerson, University of North Carolina: The writer begs to disagree with Professor Bailey's article in the November number of the JOURNAL OF ENGINEERING EDUCATION entitled "A Suggested Method of Presenting Newton's Second Law of Motion."

In attempting to evade the idea of *mass* in presenting Newton's Second Low of Motion, Pdofessor Bailey gives as a universal law of motion applying to a given body at any point on the earth's surface, the statement:

$$F = Ka. \qquad (1)$$

But Eq. (1) does not fully state the law of motion formulated by Newton. This law is to the effect that when a body is acted upon by an unbalanced force, it is *accelerated* in the direction of the force by an amount which is directly proportional to the *force* and inversely proportional to the *mass* (or inertia) of the body. Hence we should have:

$$F = KMa. \qquad (2)$$

According to the law as stated in Eq. (1) by Professor Bailey, one might infer that when the acceleration changes, the force only must change. Now if we imagine the mass of the body reduced uniformly while the acceleration is increased at the same rate, then the force remains constant. Eq. (2) shows this to be the case. But Eq. (1) does not mention mass at all; hence it is an incomplete statement, and is not a universal law.

Referring now to Eq. (2), the writer offers the folowing as a simple method of procedure in determining the useful formula:

$$F = \frac{W}{g} a,$$

which Professor Bailey derives without introducing the idea of mass.

It is a well established fact that the *pull of the earth* on bodies is a force which, acting alone, will produce an acceleration of g feet per second^2 regardless of the quantity of matter contained in the body.

Hence substituting in Eq. (2), we have:

$$W = KMg. \tag{3}$$

Dividing Eq. (2) by Eq. (3) gives:

$$\frac{F}{W} = \frac{a}{g}$$

or

$$F = \frac{W}{g}a. \tag{4}$$

It is seen that Eq. (4) is entirely independent of the units of mass.

On comparing Eqs. (4) and (2), it follows that

$$KM = \frac{W}{g}$$

and

$$M = \frac{1}{K}\frac{W}{g}. \tag{5}$$

Obviously the unit of mass whether large or small, depends upon an arbitrary value of K; and as has been stated before, Eq. (4) remains unchanged whatever value may be assigned to the constant K.

If we assume $K = 1$, as is customary for the sake of simplicity, then

$$M = \frac{W}{g}.$$

Also if

$$K = \frac{1}{32.2},$$

then

$$M = 32.2 \frac{W}{g}. \qquad (6)$$

Taking an average value of $g = 32.2$, we have

$$M = W.$$

Hence on this basis, the number of units of mass in a body may be regarded as identical with its weight. But this chosen unit is contrary to custom.

In conclusion, the writer sees no escape from the idea of mass in studying thoroughly the subject of kinetics. It is involved when dealing with the moment of inertia of solids, and it is an integral part of Newton's Second Law of Motion, even if it is not mentioned in the final formula as used by engineers.

Robins Fleming, American Bridge Co., New York City: Professor Bailey's Suggested Method of Presenting Newton's Second Law of Motion in the November issue of the JOURNAL brings to the mind of the writer the various wordings of the Law as given in textbooks. After reading the article he turned to the three that happened to be near at hand and found the Law stated as follows:

Rankine, *Applied Mechanics:* "Change of momentum is proportional to the impulse producing it."

Lanza, *Applied Mechanics:* "Change of momentum is proportional to the impressed moving force, and occurs along the straight line in which the force is impressed."

Poorman, *Applied Mechanics:* "A body acted upon by a resultant force receives an acceleration in the direction of the force which is proportional to the force and inversely proportional to the mass of the body."

Further variations may be found elsewhere—all of which tends to confusion in the minds of those who have long been out of college and need review their early studies.

As given in Motte's Translation of the *Principia* the Law reads:

"The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed."

It would be a great advantage if writers of textbooks would follow the course of Todhunter who more than fifty years ago in his *Mechanics for Beginners* wrote:

"We have followed Newton for two reasons. In the first place, his mode of stating the Laws of Motion seems, to say the least, as good as any other which has been proposed; and in the second place, there is very great advantage in a uniformity among teachers and students as to the first principles of the subject, and this uniformity is more likely to be secured under the authority of Newton than under that of inferior names."

EXTENSION OF ENGINEERING EDUCATION IN THE METROPOLITAN AREA.

BY W. E. WICKENDEN,

Director of Investigation.

This subject was the principal theme of the fall meeting of the Greater New York-New Jersey Section of the Society. The following remarks, abstracted from the discussion, may suggest the desirability of a study of their distinctive functions by other groups of institutions having common situations and problems.

In the metropolitan area we have eight colleges of engineering enrolling 2500 full-time or cooperative day students and 2000 of college rank in evening courses. In all, we have the equivalent of about 3000 engineering students in the usual sense of enrollment statistics. To put the case in a nut-shell, in an area having nearly one-tenth of the national population and far more than one-tenth of its total of engineering activity, we have about one-twentieth of the number of colleges and one twentieth of the total of students.

This situation raises the question, do we need more institutions, or larger or different ones? It is significant that over the country as a whole, engineering education is prospering chiefly in rural areas. The institutions which have declined in enrollment are all in great urban centers, those which have increased greatly are nearly all in the open country. Neither New York nor Chicago is outstanding as a center of engineering education. Precisely the reverse is true in Europe. London, Glasgow, Paris, Berlin, Vienna, and Milan, are all conspicuous in their respective countries. In America, apparently, engineering colleges are more often agencies for facilitating the flow of country boys to city jobs.

New York figures in engineering education clearly much more as an importer than a producer. Ought our institutions

to work chiefly with raw materials and carry out the entire process, or ought they to serve largely as agencies for the further refinement and completion of semi-finished materials?

The inherent possibilities of improvement in resident day education are limited. We must accept four years as about the limit of our income of time and incentive, and of contact between education and reality in the experience of the student. A minority—perhaps fifteen per cent, perhaps twenty-five per cent—can be served to advantage through more extended resident programs. For the remainder, part-time education in conjunction with early experience affords the chief possibility of more extended and better training. This is partly a college problem, partly an industrial problem, and partly a problem for the national societies of the engineering profession. It is largely, if not wholly, a city problem and conspicuously a New York problem.

The problem is partly one of reciprocity between the colleges. It suggests the need of specialization by institutions in advanced work for graduates. It calls us to face the question of how largely colleges should try to hold on to their alumni and seek to provide, even across barriers of distance, for their need of further training, and how largely they should stand ready to hand them on to some other institution. There is equally involved the question of how far industries should meet this need under their own auspices, and how and when they should enlist help from the colleges. Can recognition and credentials be given for perfectly valid, and sometimes highly admirable, education given by industrial concerns? Can it be coordinate in some way with advanced extension work by the universities?

Possibly a solution to some of these questions can be found if we can set up a joint tribunal of the colleges and the national engineering societies, under which to develop a certification of young engineers by the profession, and tie in certification of this character with the award of the professional degree of engineer.

OBITUARY

Emile Jerome Fermier

While in the act of writing a message to inform relatives of the death of his wife, Professor Emile Jerome Fermier, head of the Department of Mechanical Engineering and Vice-Dean of the School of Engineering, A. & M. College of Texas, died suddenly Monday morning, December 19, about 4 o'clock in Bryan.

Mrs. Nora Barnhart Fermier, wife of Professor Fermier, died about 3 o'clock the same morning in the hospital at Bryan. She had been ill for some time. Following her death, Professor Fermier went to railroad signal tower, the Western Union Telegraph office being closed, to file message of her death to relatives. While writing the message he complained of dizziness. He was given a chair, and a physician summoned but death overtook him before the doctor could arrive. Cause of his death was assigned as heart trouble.

Four children survive Professor and Mrs. Fermier. They are: Florence, 18, freshman at the College of Industrial Arts; George 17, freshman at the A. & M. College; Emily, 14, with an aunt in Chicago, and Bertha, 11.

Professor Fermier was born in Indiana, October 7, 1869. He received the B. S. degree from Valparaiso University, Valparaiso, Ind., in 1887, and took the degree of bachelor of mechanical engineering from Purdue University in 1894 and the M. E. degree from the same university in 1895.

He came to A. & M. as head of the department of mechanical engineering in 1906, following four years as professor of mechanical engineering at Purdue. In the summer of 1926, he was made vice-dean of the school of engineering at A. & M.

Professor Fermier was an outstanding man in his field. He was an excellent instructor and graduates in mechanical engineering from A. & M. during his tenure as head of the department are scattered all over the world. Professor Fermier had been an active member of the Society since 1903.

Hazen Greeley Tyler

Hazen Greeley Tyler was born on March 21, 1890, in Brooklyn, New York. There he attended the public schools, and the Polytechnic Institute, from which he was graduated in 1911 with the degree of E.E. Remaining at the Institute as an assistant in mechanical engineering from 1911 to 1916, he received the degree of M.S. in 1912, and M.E. in 1913. During this period he also studied at New York University, from which he received the degree of Sc.D. in 1916. In 1916, he went for a year to the Rensselaer Polytechnic Institute, Troy, N. Y., as an instructor in mechanical engineering. His summers were not idle; he worked with the New York Edison Company under Mr. George Orrok in 1912 and 1913, and in the research department of the Western Electric Company in 1917.

In October, 1917, Dr. Tyler came to New York University as Assistant Professor of Mechanical Engineering. In 1924, he was made Associate Professor of Experimental Engineering, and in 1926, Professor of Experimental Engineering. He was a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, and the American Physical Society.

Dr. Tyler's death brought to a close a life filled with enthusiastic activity in the teaching profession, to which he brought a point of view reinforced by close contact with engineering practice and an unusual administrative ability. Coming to New York University as a vigorous young man at a time when expansion of the College of Engineering was beginning, Dr. Tyler joined with Professor Bliss in the work of providing the Sage Laboratory with its elaborate equipment and in laying out the plans of the building. He lived to see the first two of a group of notable engineering buildings completed, and to direct the character of the work done in them by undergraduate classes and research workers. He was largely responsible for the work done by the Popular Science Institute of Standards, whose methods of testing radio

apparatus and tools have contributed greatly to improvements in these fields.

When the Evening Engineering Division of New York University was reestablished in 1922, Dr. Tyler was chosen to organize and administer it. When the evening courses were started in February, 1922, there was an enrollment of 27. In September, 1922, the enrollment was 45. The enrollment reached 314 in September, 1926, more than half that of the College of Engineering of which this work is a part. At the present rate of growth the number of day students will be outnumbered by the evening students in four years.

Dr. Tyler's personality and extensive experience in industry largely account for the success of the Evening Engineering Division. The students appreciated the fact that Dr. Tyler was able to talk their language and understood their personal problems in seeking advancement in their professional occupations. It was his practical advice, coupled with his experience as a teacher that attracted men to the classes under his direction and made the venture of dividing the engineering work between the Heights and the Square a success.

Those who knew Dr. Tyler realize that his untiring fidelity to this work, often until after midnight registering and advising them in the selection of courses, contributed to the strain under which he was working and which had its effect in weakening his general condition just prior to his death. What he accomplished in establishing evening courses in engineering for men who had not been able to complete their education is deeply appreciated by them. Dr. Tyler extended a personal interview to every applicant, and at the beginning of the term many waited in line three or four hours to have the opportunity of getting the advice which would help them in their advancement professionally. The least that the College of Engineering can do today is effectively to carry on the work so ably originated by Dr. Tyler, so that it may become a monument to his determined efforts in meeting an insistent demand for regular engineering courses available in the evening.

COLLEGE NOTES

The **Polytechnic Institute of Brooklyn,** through its Faculty and Corporation, has voted to raise the standard of its Engineering degrees by increasing the requirements for these degrees. The resolutions adopted were based upon the recommendation of the Faculty Committee on Curriculum and Educational Policy which has been studying the problem for the past year. Previously the degree of Civil, Electrical or Mechanical Engineer has been granted upon the successful completion of four years of prescribed work. The degree of Chemical Engineer has only been granted upon the completion of five years of work. Under the new plan, which becomes operative with the class of 1932 which enters next September, the degrees of Bachelor of Civil, Electrical and Mechanical Engineer will be granted at the end of the regular four-year course. The Bachelor of Chemical Engineering will be granted at the end of a five-year course. Then upon the completion of one year of actual experience in the Engineering field and upon completion of twelve semester hours graduate evening work at the Institute, the degree of Civil, Electrical, Mechanical or Chemical Engineer will be granted. Or, the engineering degree may also be gained by three years of approved engineering experience and the submission of a thesis. The granting of engineering degrees for men of the evening courses will be governed by similar requirements as those of the day courses, though here the engineering experience may be concurrent.

During the summer months the **University of Detroit** moved from the old campus located near the heart of the city on East Jefferson Avenue to their new quarters, situated six miles north of the City's Center, on Six Mile Road and Livernois Avenue. Six buildings have been completed; the Faculty Building, Science Building, Chemistry Building, Commerce and Finance Building, Engineering Building, and Power

Plant. The present plans call for thirty-three buildings and a campus of eighty acres. All buildings are of the Spanish type of architecture three stories high. The structural portions are of reinforced concrete, the exteriors of Ohio Briar Hill Sandstone of a beautiful buff color, and the roofs of red tile. Three new buildings are to be started the coming spring, a Gymnasium, Library, and Arts Building.

The Engineering Building will accommodate 1400 students on the coordination plan. It is 220 feet long by 160 feet deep in two sections. The main section which is three stories high contain classrooms, lecture halls, the larger drafting rooms, and administration offices. The laboratory section is to the rear of the main section running the full length of the building, 80 feet wide and two stories high. A mezzanine runs around the entire laboratory with a cross walk in the center. Off from the mezzanine are the smaller classrooms, and drafting rooms for upper classes, and faculty offices. Besides the main laboratory which is used by all departments, there are two smaller laboratories, the physical testing laboratory, and the cement-concrete testing laboratory.

Due to the increase in attendance in the Engineering School, which now numbers 850, several additions have been made to the faculty: Clair C. Johnston, Instructor in Civil Engineering, Professor Walter S. Weeks, Instructor of English; Mr. Clayton Pajot, Instructor in Mathematics; Mr. Charles Berthet, Instructor in Mathematics; Mr. Kimpler, Instructor in Engineering Drawning.

The Speed Scientific School of the **University of Louisville** started its third year last September with an enrollment of 110. The first senior class will graduate next June from the departments of civil, electrical, and mechanical engineering. The following year there will be graduates from the chemical engineering department in addition to these three departments.

Although much of the laboratory equipment was purchased in the first year of the School's existence, a large amount was added this past summer and fall, and more is to follow. The

Materials Testing Laboratory is one of the best and the Highway Laboratory is very complete. The Hydraulics Laboratory will be installed this coming winter. The Mechanical Engineering Laboratory is well equipped and the heating plant of the University is so arranged that the boilers and auxiliaries can easily be used for experimental and test purposes. The Electrical Engineering Laboratory is in accord with the most modern practices. All of the laboratories have already outgrown their allotted space.

Two new faculty appointments were made this year: W. R. McIntosh, assistant professor of civil engineering, and S. T. Fife, assistant professor of electrical engineering. H. H. Fenwick has been promoted to assistant professor of engineering drawing. The faculty now consists of 13 full-time members and 6 members of the College of Liberal Arts faculty who are teaching part-time in the Speed School.

Dean B. M. Brigman was re-elected to serve for a second year as chairman of the Louisville Section of the American Society of Mechanical Engineers, and D. C. Jackson, Jr., was reelected as chairman of the Louisville Section of the American Institute of Electrical Engineers.

About 85 per cent of the full-time faculty members are members of or have applied for membership in the Society for the Promotion of Engineering Education. Two of the part-time faculty members also are members of the Society, which gives a total of 77 per cent of the faculty who are members of the S. P. E. E. W. B. Wendt has been elected chairman of a local organization to effect the establishment of a Section of the Society in this territory in cooperation with the members at the University of Kentucky and Evansville College.

University of Maine.—By vote of the College of Technology Faculty at a meeting December 13, our foreign language entrance requirements are reduced from three years in any one foreign language, or two years in each of two, to two years in any one.

Beginning with the spring semester an elective course will

be offered to the College of Technology seniors, carrying credit of one unit and consisting of a series of lectures given by professional engineers and industrial men. The subjects embraced will be Management and Executive Functions, Design, Operation, etc.

University of Michigan.—During the past summer the Transportation Library, which had been in temporary quarters, was moved to its commodious quarters on the ground floor of the East Engineering Building. A special librarian has been appointed by the Regents so that the work of classification and indexing has begun. This library makes available at once for advanced and graduate students over 40,000 books, pamphlets, documents, and reports bearing on the subject of transportation. The collection has been gotten together through the enthusiasm and effort of Professor John S. Worley, who came to the University in the fall of 1923 as Professor of Transportation Engineering. Finding that not only was the collection of material in his subject very incomplete, but that there was really no comprehensive collection in any of the large American universities, he set to work collecting books, reports, pictures, and other material bearing on all phases of transportation.

Through the generosity of Messrs. Alex Dow of the Detroit Edison Co., Mr. C. S. Mott of Flint, Dodge Brothers of Detroit, the Hudson Motor Car Company, the Reo Motor Company, and the Ford Motor Company, the sum of twenty thousand dollars has been made available; of this amount less than half has been expended. The purchases from this fund, together with the gifts of three private collections, and large contributions of books from the Pennsylvania Railroad and from two alumni of the University of Michigan, together with a hundred or more gifts of from one or two to fifty or more volumes, have enabled us to assemble a collection of about 40,000 pieces.

The Transportation Library covers in a general way material on waterways, transportation by land, transportation in the air, communication and public utilities. It consists

of text and reference books, documents, manuals, periodicals, society proceedings, reports, laws and charters, correspondence and personal papers, prints and pictures, maps and atlases, and lantern slides. It is proposed to make this one of the most complete libraries in this country on all phases of transportation.

The University of New Mexico.—The College of Engineering, which is a part of the University of New Mexico, has had a very remarkable growth this year, the attendance having increased fifty per cent. One of the interesting features of the increase has been the large number of transfers from other schools to the upper classes. Along with the growth in size of the student body we have increased the personnel of our faculty by two members and replaced two members.

The new members are: Adelbert Diefendorf, Associate Professor and Head of the Department of Civil Engineering, a man of wide practical and teaching experience, especially in steel and concrete structural work, who comes to us from the South Dakota School of Mines. Mr. F. M. Denton, Associate Professor of Electrical Engineering, formerly Associate Head of the Department of Electrical Engineering in the University of London. Mr. John B. Baker, Assistant Professor of Mechanical Engineering, who was for some years assistant in the Mechanical Research Laboratory at the University of Illinois. He comes to us directly from Lafayette College. Mr. V. L. R. Beaumont, Instructor in Shop Practice and Mechanical Drawing. A man of long teaching experience and who comes to us after four years at the Agricultural and Mechanical College of Texas.

NEW MEMBERS

ABRAHAM, JOHN B. F., Instructor in Electrical Engineering, Cooper Union, New York City. E. E. Foss, H. W. Merritt.

BENNETT, DONALD M., Assistant Professor of Physics, University of Louisville, Louisville, Ky. D. C. Raub, R. L. Koch.

BRITTAIN, MARION L., President, Georgia School of Technology, Atlanta, Ga. W. V. Skiles, P. S. King.

CLOUSE, JOHN H., Instructor in Physics, Washington High School, Sioux Falls, S. Dak. F. L. Bishop, Nell McKenry.

ERNST, ROBERT C., Assistant Professor of Chemical Engineering, University of Louisville, Louisville, Ky. B. M. Brigman, W. B. Wendt.

FERNALD, ERNEST M., Assistant Professor of Mechanical Engineering, Lafayette College, Easton, Pa. D. B. Prentice, F. L. Bishop.

KAULFUSS, JULIUS E., Professor of Highway Engineering, The Pennsylvania State College, State College, Pa. O. K. Harlan, J. I. Clower.

KIDNEY, CARLETON B., Instructor in Civil Engineering, Lafayette College, Easton, Pa. F. O. Dufour, F. L. Bishop.

LEE, FRANK H., Instructor in Engineering Drafting, Columbia University, New York City. C. B. Pegram, F. L. Bishop.

MASON, HOWARD W., Head, Department of Experimental Engineering, Georgia School of Technology, Atlanta, Ga. R. S. Howell, D. P. Savant.

MILLER, ARCHIE R., Assistant Professor of Electrical Engineering, Lehigh University, Bethlehem, Pa. C. R. Richards, F. L. Bishop.

RAGATZ, ROLAND A., Assistant Professor of Chemical Engineering, University of Wisconsin, Madison, Wis. O. L. Kowalke, F. L. Bishop.

SAHAG, LEON M. Assistant Professor of Engineering Drawing, Texas Technological College, Lubbock, Texas. W. J. Miller, F. L. Bishop.

SUMMERS, ROBERT E., Instructor in Mechanical Engineering, Oregon State Agricultural College, Corvallis, Ore. W. H. Martin, Morris Wenk.

WARNER, FRANK M., Assistant Professor of Engineering Drawing, University of Washington, Seattle, Wash. C. E. Magnusson, E. R. Wilcox.

WHITE, WILLIAM E., Instructor in Civil Engineering, The Rice Institute, Houston, Texas. L. B. Ryon, J. H. Pound.

ZIMMERS, PETER J., Assistant Professor of Education, Case School of Applied Science, Cleveland, Ohio. K. O. Thompson, F. L. Bishop.

Total new members, Dec. 26, 1927 103

ITEMS OF INTEREST

President Sackett has appointed Vice-President C. E. Magnusson to represent the Society for the Promotion of Engineering Education at the inauguration of Matthew Lyle Spencer as President of the University of Washington on Wedesday, February twenty-second.

* Perhaps the most interesting recent advances have been made in the field of education, however, and in this field the Corporation has been able to make helpful contributions. The Modern Foreign Language Study and the Engineering Education Study, both now drawing to a close, furnish good examples of what may be accomplished. While it is too early to anticipate the full results, it is safe to say that the two enterprises mark a step forward in the organization and conduct of fundamental studies of this character, and the Corporation should record its high appreciation of the work done by those in responsible charge. Not the least of their achievements has been to establish a broad basis of cooperation and to develop and maintain a fine spirit of friendly team-work. All this has more than a sentimental value, for the studies were undertaken and financed for a very practical purpose, namely, to improve conditions affecting the study of hundreds of thousands of young Americans, and when placed in the hands of teachers and executives who feel that they are dealing not with *their* report, but with *our* report, the findings and recommendations are much more likely to result in actual progress.

* From the Report of the President, Frederick P. Keppel, Carnegie Corporation of New York.

SECTIONS AND BRANCHES

The third meeting of the **New York-New Jersey Section** occurred at New York University, University Heights, New York City, on the afternoon and evening of December 3, 1927.

A large number of members and guests assembled at the new Nichols Chemistry Building at two o'clock and inspected this very attractive building which was being dedicated on the same afternoon, renewed acquaintances and secured dinner tickets.

Dean Pegram, chairman of the Section, called the formal meeting to order in an adjoining building at two forty-five.

Chancellor Brown extended a cordial greeting and a warm welcome to the section after which the regular afternoon program was completed. The program proved to be one of unusual interest and value with an attendance of nearly one hundred and fifty.

Following the afternoon program the visitors were entertained at the Faculty Club by the ladies who served tea and aided in a pleasant social hour.

The Aeronautic Wind Tunnel in the Guggenheim Aeronautical Building was opened for inspection and attracted most of the visitors inasmuch as this is one of the largest and most important new research stations for the study of aerodynamics.

One hundred and nine sat down to dinner at 7 o'clock P.M. Mr. Harry F. Guggenheim, Dean R. L. Sackett, President, and Dr. F. L. Bishop, Secretary, of the National Society, were the guests of honor. Dean Sackett, Dr. Bishop and Professor Scott, Chairman of the Board of Investigation, were called on to speak and responded with appropriate remarks in regard to the National Society and its plans for the future. Dean Greene of Princeton delivered an address, "The Liberal Curriculum in Engineering as Practiced at Princeton University."

Dean Arthur M. Greene, Jr., of Princeton was elected

Chairman of the Section and Dean E. H. Rockwell of Rutgers University was reelected Secretary.

Rutgers University extended an invitation for the Section to meet at New Brunswick in the Spring and the Brooklyn Polytechnic Institute extended an invitation for it to meet in Brooklyn next winter. Both invitations were accepted. Resolutions were adopted thanking the officers, faculty and ladies of the University for their very successful efforts in making the meeting a success.

The meeting adjourned to the Auditorium where Mr. Harry F. Guggenheim, President of the Daniel Guggenheim Fund for the Promotion of Aeronautics, delivered a remarkably clear and informatory address on the present status and future prospects of Aeronautics.

Baron Shiba's Very High Speed Motion Pictures of Aerodynamic Flow were shown and explained by Professor Alexander Klemin of New York University and these were of tremendous interest not only for the direct results but on account of the very ingenious methods used for obtaining such high speed results, some of the pictures being made at the rate of 20,000 per second.

The afternoon program was as follows:

Word of Welcome.....Chancellor Brown

"Opportunities in the Metropolitan District for the Extension of Engineering Education"

Pres. Parke R. Kolbe, Brooklyn Polytechnic Institute.
Dr. W. E. Wickenden, Director, S. P. E. E.
Assoc. Dean C. P. Bliss, New York University.

"A Practical Step Toward Improving Methods of Teaching"

Prof. H. P. Hammond, Assoc. Director, S. P. E. E., Brooklyn Polytechnic Institute.
Prof. S. D. Barclay, Pratt Institute.

"The New York University Engineering Honor System"

Prof. George A. Stetson, New York University.

EDWARD H. ROCKWELL, *Secretary.*
N. Y.-N. J. Section, S. P. E. E.

The **Purdue Branch** held a very interesting meeting in the Engineering Administration Building November 18.

The Minimum Requirements for certain courses given at Purdue was read and discussed by: Professor William Marshall, Mathematics department, Professor D. D. Ewing, Electrical Engineering, Professor J. Rising, Practical Mechanics, Professor J. L. Bray, Chemical Engineering, Professor Ferry, Physics, Professor J. L. Cattell, Modern Languages, Professor R. B. Wiley, Civil Engineering, Professor R. E. Nelson, Chemistry, and Professor Bartlett form the Mechanical Engineering.

The subject attracted 64 teachers and much interest was shown in the meeting. Prof. O. L. Greiner the new president of the society presided.

BOOK REVIEWS

Examples in the Strength and Elasticity of Materials. G. W. Bird. Published by Longmans, Green & Co., New York City, 1927. Price $4.00.

Devoted exclusively to problems. Nearly two hundred examples covering a large range of theory and application, with typical solutions given for a few under each subject. Many of the more important formulae are derived by the problem method. Should prove a valuable adjunct to technical courses taught by the lecture method or texts which do not emphasize the problem feature.

J. S. L.

Thermodynamics Applied to Engineering. A. F. Macconochie. Longmans, Green & Co. $4.50. xiv + 260 pp., 65 Figs., xiii Plates, 1927.

1924 Heat-Entropy Steam Chart, 1924 Mollier Ammonia Chart, Steam Tables, Ammonia Tables, Mercury Vapor Tables, Carbon Dioxide Tables.

The purpose of this text is to present the principles of engineering thermodynamics in the simplest manner and to illuminate these conceptions by reference to the best British and American practice in the major fields of their application. In the selection of examples for illustration, stress has been laid on recent developments likely to make a strong imaginative appeal on account of their unusual interest. The standard of the work is that which is characteristic of University degree requirements in both England and in America.

There are sections on general thermodynamics, fluids in motion, thermodynamics of the boiler, the binary vapor prime mover, the steam engine, the unaflow engine, the steam turbine, the internal combustion engine, the Diesel engine, the gas turbine, and refrigerator.

Illustrative examples serve to clarify the explanations throughout.

W. F. W.